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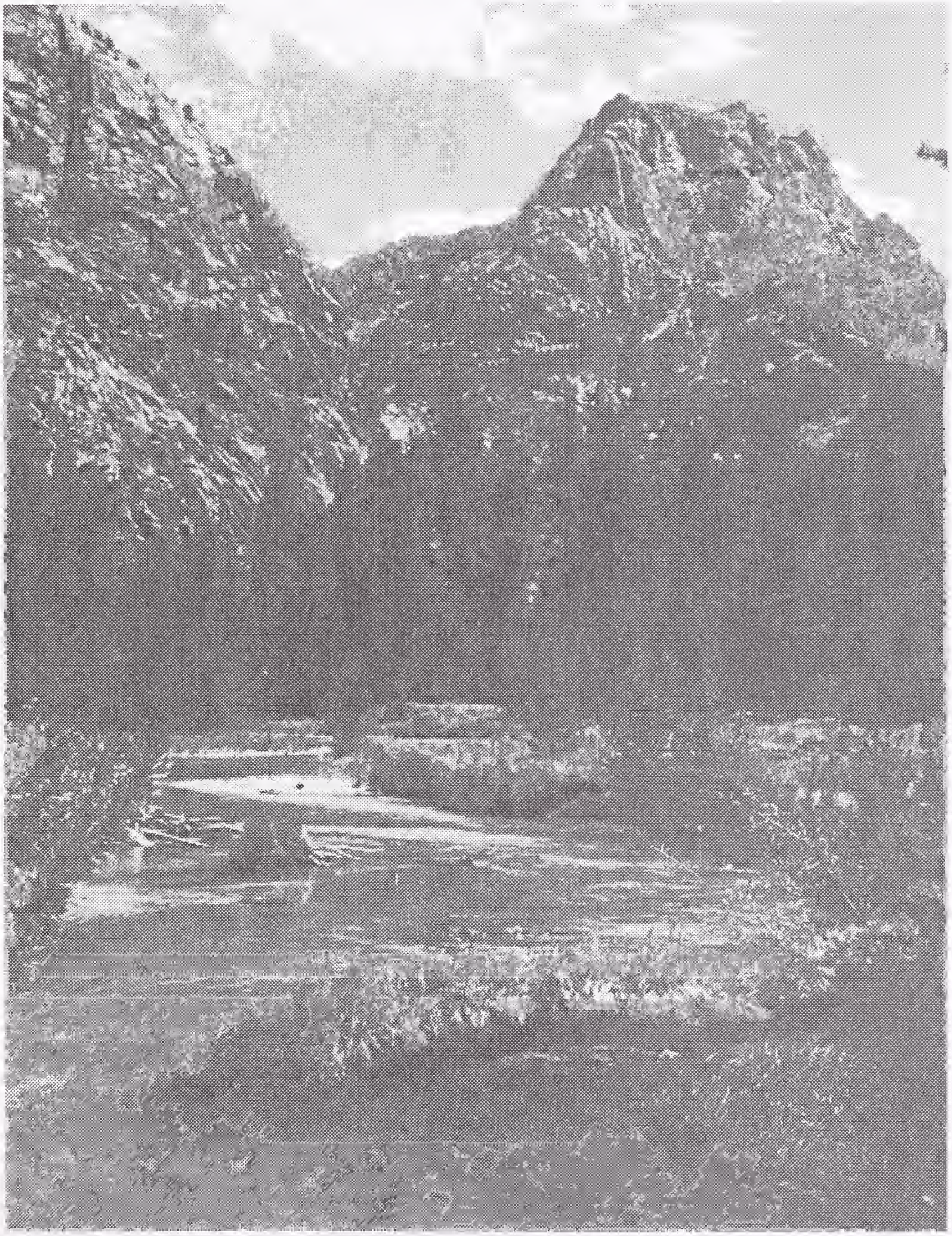
June 1996

Conservation Assessment For Inland Cutthroat Trout

Distribution, Status and Habitat Management Implications



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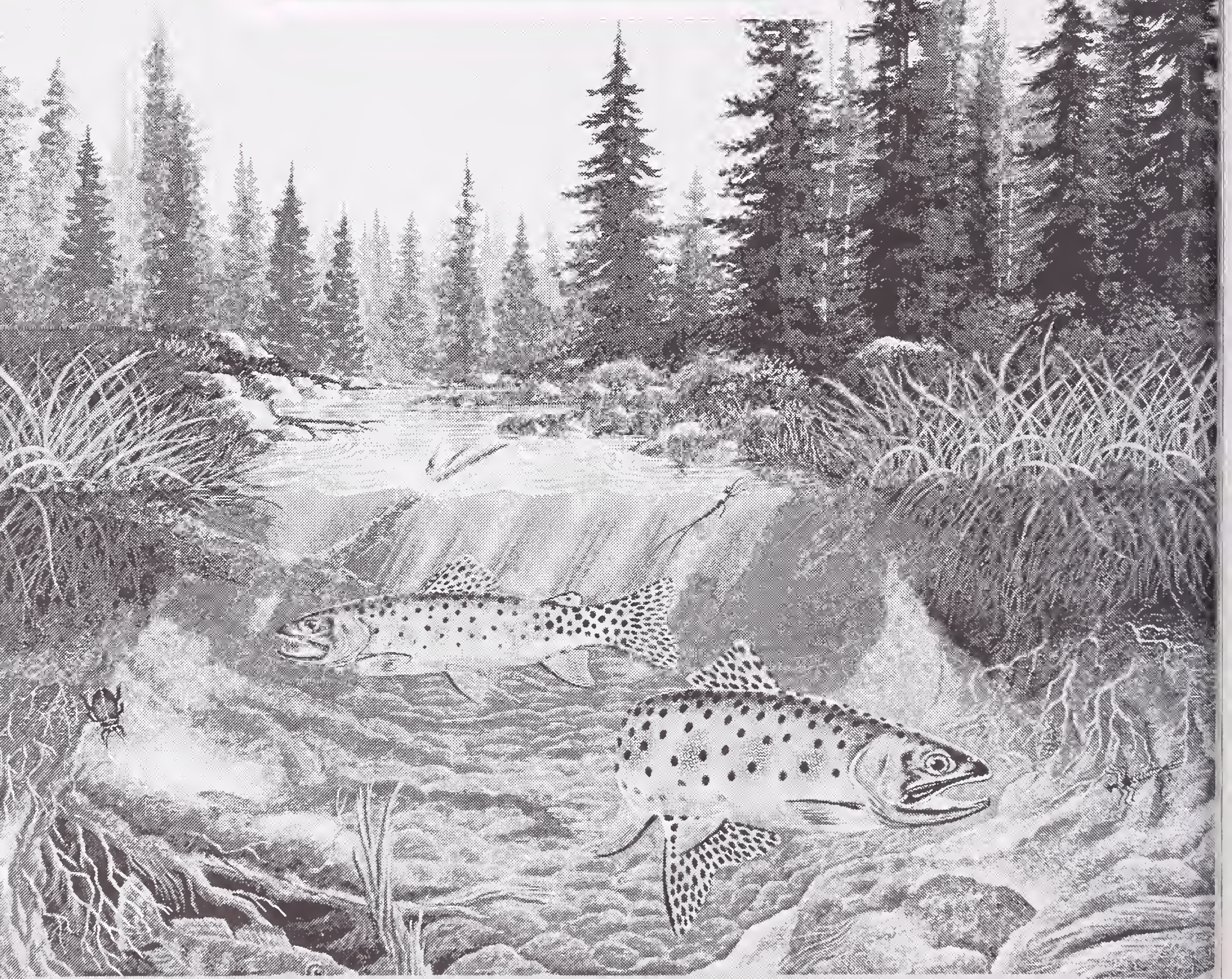

"A thing is right when it tends to preserve the integrity stability and beauty of the biotic community"

-Aldo Leopold

Duff, Donald A., tech ed. 1996. Conservation assessment for inland cutthroat trout status and distribution. U.S. Department of Agriculture, Forest Service, Intermountain Region, Ogden, Utah.

ABSTRACT

This document focuses on the current status, distribution and range for five subspecies of cutthroat trout *Oncorhynchus clarki*, which are found largely on national forest system (NFS) lands and ecosystems in the Rocky Mountain and Intermountain West within the United States from the Canadian to Mexican border. The five subspecies are designated either species of special concern or sensitive. These subspecies are presently restricted to a fragment of their former range, and they primarily occupy small, high-elevation streams in remote headwaters of watershed basins. In the past, little was known about life history, genetics, habitat relationships, and range of the five subspecies, but within the last decade more management studies and research have been conducted by state and federal agencies and academia. All subspecies within their historic (from 1800 A.D.) aquatic ecosystems have been reduced from their historic occurrence and productivity. They have been reduced from human activities more so than natural occurrences, such as introductions of non-native fishes, habitat degradation and fragmentation, and overfishing. Current management is centering upon development of conservation strategies and basin-wide assessments, and their cooperative and interagency implementation through Forest Plans, public lands Resource Management Plans and State Fisheries Management Plans. These plans and resulting conservation agreements and strategies focus on restoration of aquatic habitats, maintenance of existing indigenous cutthroat populations, and native cutthroat reintroduction into waters within their historic range.

Keywords: cutthroat trout, *Oncorhynchus clarki*, indigenous species, non-native species, conservation assessment

Cover photography by Donald A. Duff; painting by Ralph Butler

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USDA Forest Service
Intermountain Region
Ogden, Utah

June 1996

CONSERVATION ASSESSMENT for INLAND CUTTHROAT TROUT

DISTRIBUTION, STATUS AND HABITAT MANAGEMENT IMPLICATIONS

Westslope Cutthroat Trout, *Oncorhynchus clarki lewsi*

Yellowstone Cutthroat Trout, *Oncorhynchus clarki bouvieri*

Bonneville Cutthroat Trout, *Oncorhynchus clarki utah*

Rio Grande Cutthroat Trout, *Oncorhynchus clarki viriginalis*

Colorado River Cutthroat Trout, *Oncorhynchus clarki pleuriticus*

Technical Editor:
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CONTENTS

PREFACE

This conservation assessment for inland cutthroat trout focuses on five subspecies found largely on national forest system (NFS) lands in the Rocky Mountain and Intermountain West in the United States from the Canadian to Mexican borders. While all cutthroat trout were derived from a common ancestor, the divergence of these subspecies has occurred at different rates to the extent that one subspecies was proposed for elevation to full species status (Allendorf and Leary 1988) and another may be composed of up to three genetically distinguishable groups (Shiozawa and Evans 1994). The USDA Forest Service (FS) selected these five subspecies because they have been designated as species of special concern or sensitive species, and have become increasingly rare in occurrence throughout their historic range. They occupy lands managed under a variety of jurisdictions and multiple-use management. Some land management activities continue to place them at risk and trending toward further decline to extinction. Subspecies already listed under the Endangered Species Act, even though they may not be stable and secure, and those of uncertain taxonomic status were not considered.

The primary goal of the assessment is to summarize the current conservation status, distribution, and range for each subspecies. Recent treatises (Behnke 1992; Gresswell 1988; Reiman et al 1993; USDA FS 1995) summarized portions of this knowledge dealing with life histories, habitat relationships, and management and research needs, but this assessment focuses more specifically on historic and current status and management needs. The variability in length among these chapters reflects not only the variability in our knowledge but the degree to which data is available and cataloged for management use; but, not surprisingly, the most abundant subspecies seem to be also the best studied. A companion document (USDA FS 1995) identified the current state of scientific knowledge of each subspecies.

A second goal of the assessment is to help forest and land managers make well informed decisions on land use activities and management that could have consequences for either placing these species at further risk or for providing habitat conservation measures for their recovery. For most populations of these subspecies, some data is available upon which to base an informed and coordinated decision making to conserve the species and its habitat on NFS lands. Inventories to ascertain fish occurrence, abundance and distribution, coupled with genetic analyses, are currently underway in each geographic area occupied by these subspecies, and additional inventories will be necessary to identity the total phenotypic and genotypic variability of each subspecies, to recognize evolutionarily unique stocks, and to predict their interrelationship and response to management. Current management and future research must center not only on these information gaps, but also on the available state of scientific knowledge for these subspecies to perpetuate their existence.

It is implicit within this document and in each chapter that these indigenous fishes are worth saving, and that we have an ethical, legal and moral obligation as an agency, and as professional managers and scientists to prevent them being placed further at risk and accelerated toward extinction (Frankel and Soule 1981). Though many readers may share that vision, the choice of tactics to achieve it will not be unanimous, but consensus must be achieved. Agency partners, individuals, state and federal agencies, and interest groups, will differ in their desire to see federal listing for these subspecies under the Endangered Species Act (ESA). However, their common focus should be to maintain stewardship of and for the land. It is the policy and management objective of the FS to provide adequate habitat and viable populations of these subspecies on NFS lands to assure their secure and stable or expanding status without tending to place them at further risk that would lead them toward ESA listing. Because these fish are vulnerable to extinction,

we encourage open, honest involvement of all managers, scientists, and interested citizens. A shared vision of land stewardship and common understanding of the biological and physical habitat needs of the indigenous cutthroat trout is the only insurance for the future survival for these subspecies.

Donald A. Duff

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Introduction

The information contained in this status review focuses upon 5 subspecies of North American inland cutthroat trout, i.e. the Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*) and the fine-spotted cutthroat trout, (*O. c. subspp.*), principle subspecies of cutthroat trout that historically occupied the upper portion of the Snake River, within the Columbia River basin; the westslope cutthroat (*O. c. lewisi*) which occupied the Northern Rockies in Montana, Idaho, and eastern Oregon and Washington; the Bonneville cutthroat (*O. c. utah*), which occupied the Bonneville Basin within the Great Basin; the Colorado River cutthroat (*O. c. pleuriticus*), of the upper Green River and Colorado River basins in Utah, Colorado, and Wyoming; and the Rio Grande cutthroat (*O. c. virginalis*) of the upper Rio Grande River basin in New Mexico and Colorado. Figure 1 illustrates the inland cutthroat trout subspecies historic distribution within their separate hydrologic sub-basins.

General concern for the well being of these native trout species has been elevated as a result of recent assessments (Williams et al. 1989 and Warren and Burr 1994). The assessments pointed to a dramatic decline in the status of many freshwater fish species with as many as 364 freshwater fish (about one-third of the American native freshwater fishes) identified as endangered, threatened or of special concern (Williams et al. 1989). The situation is particularly bleak within the western states (Warren and Burr 1994) which have a proportionately higher percentage of imperiled native species. Western trout (Behnke, 1976, 1992) and salmon (Nehlsen et al. 1991) have suffered catastrophic declines in abundance due to essentially similar factors (e.g. exotic species introduction, habitat degradation, and overharvest).

Concern for the status of western cutthroat prompted the Forest Service to initiate Habitat Conservation Assessments for many interior cutthroat trout subspecies. In 1992, the Chief asked the Forest Service Regions to develop inter-regional habitat conservation assessments (HCA) addressing species' habitat requirements throughout their inhabited range on National Forests and Grasslands. The purposes of these HCA's are to update and synthesize existing management and research information and to develop a common base of technical knowledge for decisionmakers. To encourage shared ownership and to solicit technical assistance as well as an opportunity to facilitate informed consensus with partners, ie. state, federal, interest groups, and public interests, the HCA's were viewed as an interdisciplinary effort among resources. The HCA's provide baseline data from which to make future resource decisions on National Forest System (NFS) lands. Rather than decision documents, the HCA's are technical tools to be used by line officers and decisionmakers to develop management strategies and to identify necessary changes in current management direction or in project planning.

In 1994, the Chief further reiterated the need for HCA's to receive priority emphasis for species protection and management. Many HCA efforts require inter-regional and multi-state coordination on wide ranging species that cover more than one FS region. Examples include recent multi-agency and inter-regional efforts on bull trout (*Salvelinus confluentus*), and the Inland Native Fish Strategy.

The information contained in this HCA focuses on the five inland cutthroat trout. The goal associated with this cutthroat trout HCA is to provide information linked to habitat conditions necessary to ensure the long term survival of these subspecies within the interior western United States. In addition, population status, distribution, and trend is addressed and related to habitat and species management within the historic range of these cutthroat trout subspecies. This status assessment is designed to complement and to be an extension of an earlier HCA document on the inland cutthroat for these five subspecies which was prepared by Forest Service research fisheries

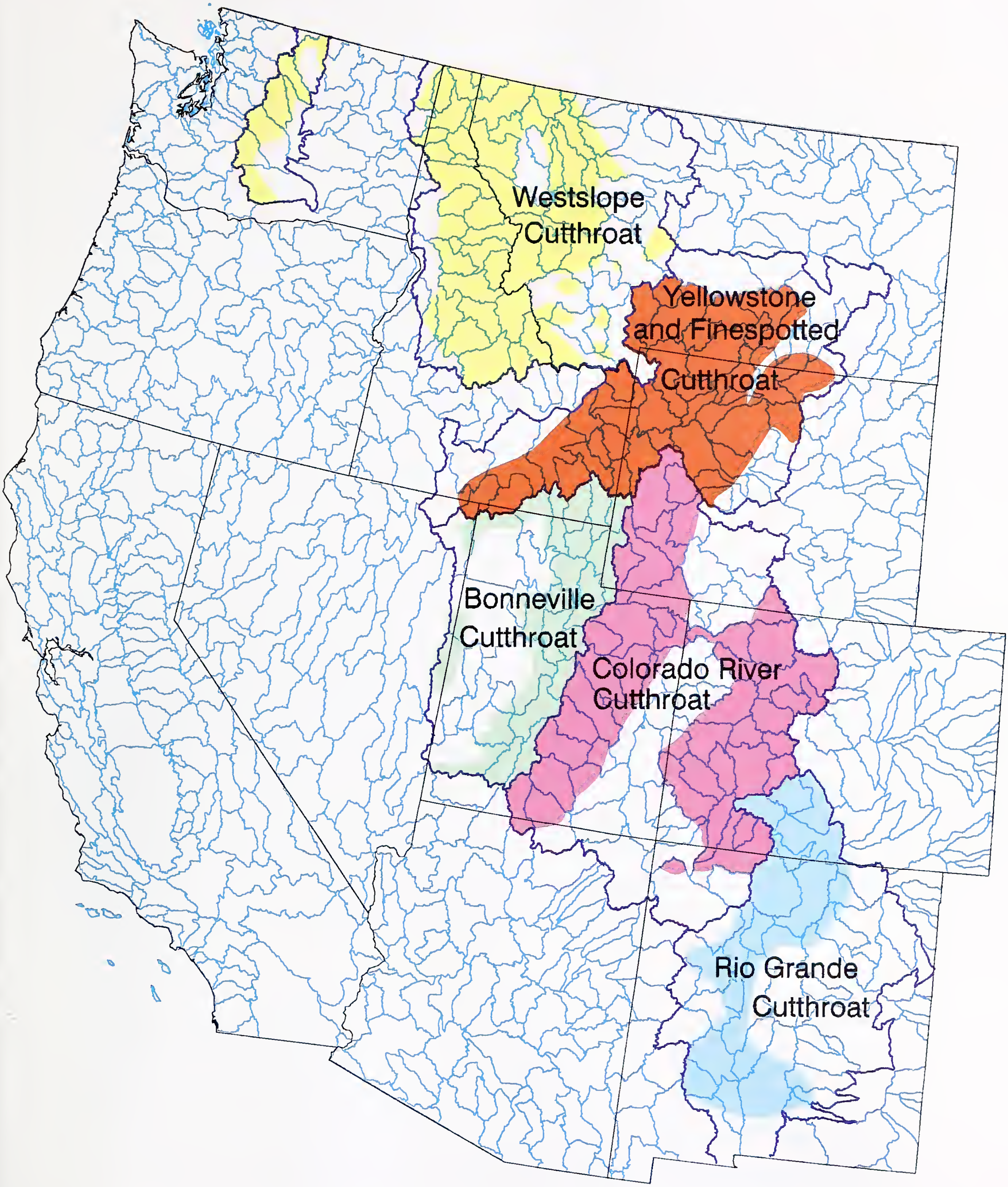

Figure 1. Western inland cutthroat trout historic distribution within their hydrologic sub-basins.

biologists to update literature and research, and provide a state of the science for each (USDA FS 1995).

ASSESSMENT METHODS

The assessment provided for a primary contact person for each of the five subspecies addressed. This was a Forest Service fisheries biologist with expertise in the subspecies, since the HCA would focus on these cutthroat trout within historic range with specific focus on State and Forest Service local and regional administrative jurisdictions. A questionnaire was developed to ascertain historic, if known, and current information on population status and distribution, as well as their well being and habitat conditions (See Appendix A). Factors affecting their condition, as well as activities occurring on National Forests were also documented. Questionnaires were sent to biologists from State Wildlife Agencies and various National Forests within the subspecies historic and current occupied ranges. In addition, other federal agencies, i.e. Bureau of Land Management (BLM) and Fish and Wildlife Service (FWS), and some partner groups were also asked to contribute information. Initially, the HCA was intended to address the subspecies, such as Trout Unlimited and others, over their entire range irrespective of administrative land ownership boundaries, i.e. such as on the BLM and State lands, but this was subsequently deleted due to the different agency constraints in time schedules, manpower, and budget differences.

The HCA information was collected on a watershed or sub-basin level with the boundaries determined by the management biologists, state and federal. For some subspecies, the U.S. Geological Survey (USGS) national hydrologic sub-basin boundary was used to reflect subspecies range. Sub-basins could contain one or more drainages or reaches. For each of these sub-basins, or assessment areas, a questionnaire was completed with all relevant information on populations and habitat conditions. Information was varied due to the wide variation in available data by geographic area, and by agency files and personal professional knowledge. It should be noted that the quality and precision of the information collected represent, to a large degree, the best professional knowledge of the biologists based upon their specific experience with the subspecies and waters being inventoried. Where available, interagency databases were used to supplement the needed information, such as the Montana Interagency Aquatic Database.

A number and variety of meeting were held by the lead biologists within their subspecific areas to obtain the needed information. The questionnaires were completed and sent to the lead biologist who tabulated the information, and in most instances helped revise and update subspecies databases, including the use of geographic information system (GIS) mapping support. In addition to the information derived from the questionnaires, some attempts were made to secure and validate historical information which made reference to the occurrence and distribution of the cutthroat subspecies.

Each chapter within this HCA assessment represents the individual knowledge of the federal and state biologists gathering the subspecies data. And while a uniform format for data presentation and summary was planned, it was not always possible to follow this since the data varied by subspecies, and in some instances, was just not available in total for each subspecies. However, each chapter represents, as much as possible, a consistent format, and is presented by the author(s) in the most representative display to synthesize available information for the reader and decisionmakers' understanding and use. In many instances, to facilitate reporting and discussion of status information, findings are presented either by State, by sub-basin, and by National Forest, or by combinations of each depending on the data available. The data in this HCA will form a baseline from which future monitoring of each subspecies will proceed, and from which management

decisions will be made to assure either survival of the subspecies, restoration of the habitat, or recovery for both.

ORIGINS AND TAXONOMIC THEORY

While it is not the intent of this HCA to provide detailed documentation of phylogeny and prehistoric zoogeography of these cutthroat trout, it is important to review the theory represented in the most recent work on native western trout (Behnke 1992). For an indepth discussion on the genesis of the native western trout, the reader should refer directly to Behnke's monograph. Phylogenetic and zoogeography theory supports the concept that, while evolutionary sequences leading to present cutthroat trout species and subspecies originated in the mid-Pleistocene era (more than one million years ago), most historical and prehistorical distributions were determined by events occurring in the last glacial and post-glacial periods (about 70,000 years ago to the present, Behnke 1992). For the purpose of this assessment, reference to the prehistoric status addresses conditions existing before the presence of white explorers (prior to 1800 AD) within the cutthroat distributional area (Figure 1). Reference to the historic status addresses conditions occurring during and subsequent to the exploration and settlement of the western Rocky Mountains by early white explorers (after 1800 AD).

Chapter 1

Westslope Cutthroat Trout
Oncorhynchus clarki lewsi

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INTRODUCTION

Westslope cutthroat trout *Oncorhynchus clarki lewisi* and Yellowstone cutthroat trout *O. C. bouvieri* most likely separated from a common ancestor prior to the last glacial period during Pleistocene times (Behnke 1992). It appears that cutthroat trout were the earliest of the trout and salmon to populate the headwaters of the Columbia River basin enabling them to colonize above major barrier falls (Behnke 1979). Headwater transfers established westslope cutthroat trout populations in the upper Missouri River and South Saskatchewan River basins. Schultz (1941) describes a direct connection between the Flathead and Marias river systems.

Current distribution (Figure 1) includes disjunct populations in Oregon and Washington and populations in the upper Columbia River above barrier falls on the Pend Oreille, Spokane, and Kootenai rivers, including British Columbia headwaters (Behnke 1992). Isolated and disjunct populations of westslope cutthroat trout in the John Day drainage of Oregon and Lake Chelan, Methow, Entiat, Yakima, and Wenatchee river drainages of Washington may have ensued from catastrophic floods as glacial Lake Missoula broke through its ice dam 12,000- 15,000 years ago (Behnke 1992). Westslope cutthroat trout are also established in the Salmon and Clearwater drainages apparently through headwater transfers from the Clark Fork River after the Yellowstone form was likely displaced by redband trout (*O. mykiss*) (Behnke 1992). East of the Continental Divide, westslope cutthroat trout occur in fragmented populations in the upper Missouri River including headwaters of the Gallatin and Madison rivers in Yellowstone National Park downstream to the confluence with the Musselshell River. Populations also occur in the South Saskatchewan drainage in Glacier National Park and southern Alberta (Behnke 1992)

ASSESSMENT METHODS

Standardized questionnaires were developed for determining the status of inland cutthroat trout. A sample of the questionnaire is included in Appendix A. Attempts were made to use the questionnaire, however due to the numerous populations of westslope cutthroat trout across its range other methods to document status were also employed. In Idaho, the status and distribution of westslope cutthroat trout was recently compiled by Rieman and Apperson (1989). Discussions with biologists suggested that this data was current and little updated data existed, therefore the information included in this assessment for Idaho was derived from Rieman and Apperson (1989).

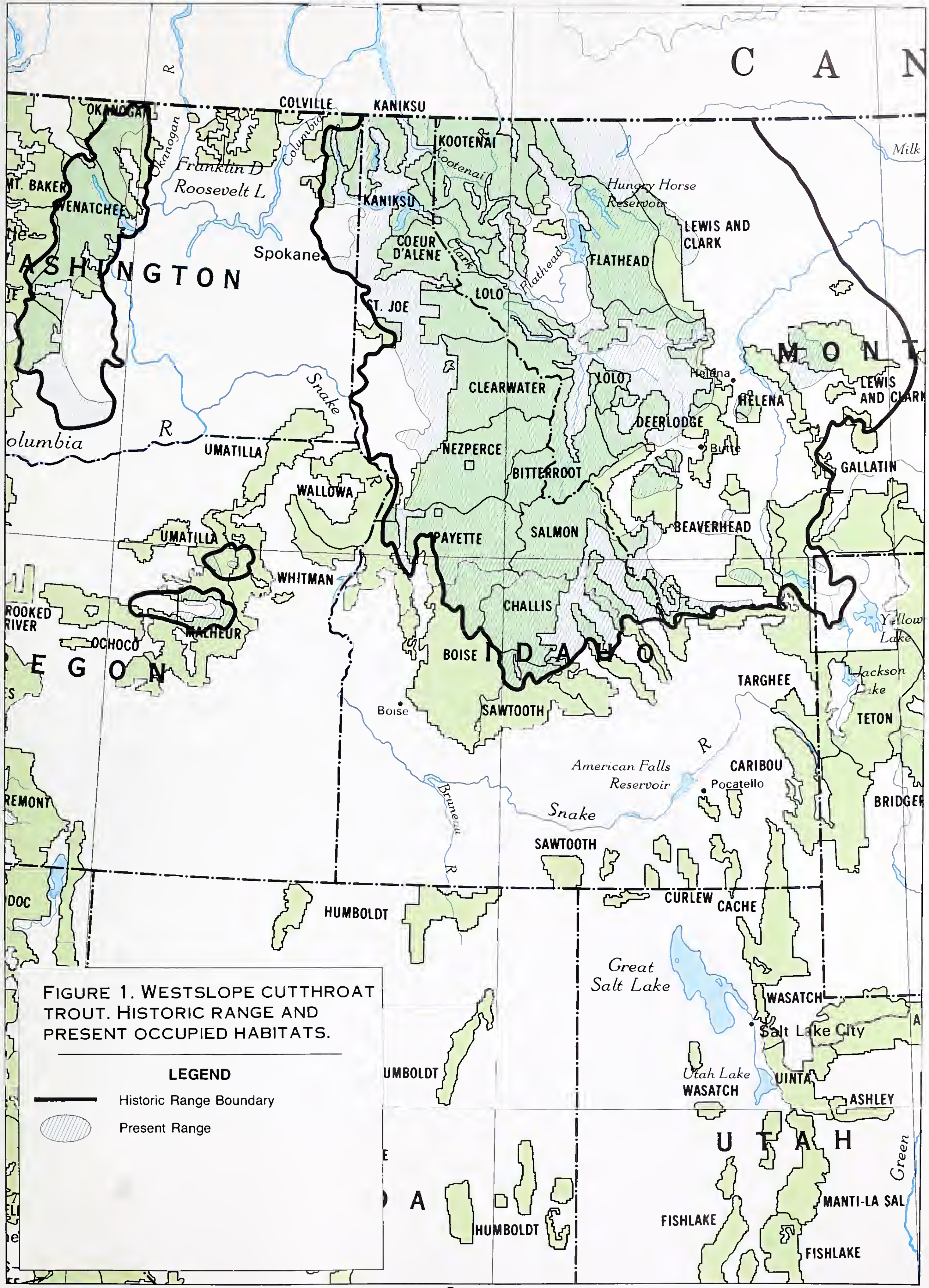

FIGURE 1. WESTSLOPE CUTTHROAT TROUT. HISTORIC RANGE AND PRESENT OCCUPIED HABITATS.

In Montana, the Montana Rivers Information System (MRIS) was updated in 1994 for westslope cutthroat. This database contains many of the components of the questionnaire, therefore the database was queried for information on this subspecies. The questionnaire was completed by Errol Claire, Oregon Department of Fish and Wildlife, for westslope cutthroat populations in the John Day River drainage, Oregon. Information for Washington was obtained through surveys and contacts with state and federal biologists.

In most cases the information contained within this assessment represents the best professional judgement of state and federal biologists in each state. There is a tremendous amount of information that is unknown about westslope cutthroat trout populations, but future surveys should help to overcome some of these deficiencies. The information presented here is a general synopsis to assess the current distribution and status of westslope cutthroat across its range. The reader is encouraged to obtain additional information from each state.

RESULTS AND DISCUSSION

Idaho

In Idaho, the historic range is believed to have been the Kootenai River drainage above its barrier falls, and the Pend Oreille, Spokane, Clearwater, and Salmon river drainages. Behnke (1992) speculates that Clearwater and Salmon river populations originated from headwater transfers from the Clark Fork River after redband trout displaced Yellowstone cutthroat which was likely the original ancestor in these drainages.

Historic abundance was thought to be high throughout this subspecies range (Rieman and Apperson 1989). Gilbert and Everman (1894) during their early explorations of the Columbia River reported that the Pend Oreille River was "abundant with trout and salmon trout" They were referring to cutthroat and bull trout. Region 1 Idaho Fish and Game Files contain reports from the St. Maries Courier reporting from 1901 to 1905 that anglers caught 50-100 "speckled trout" averaging 3 to 5 lbs.

More recently, estimates by Rieman and Apperson (1989) indicate that strong populations (> 50% of historic potential) persist in 11% of the historic range, while viable (strong and depressed) populations remain in 36% of their historic range (Table 1). Depressed populations were defined as <50% of their historic potential but were considered viable and common in samples. The potential to restore westslope cutthroat to historic levels was subjectively rated poor in 46% of this range due to their limited importance as a fishery while 20% of the populations could be restored with special regulations. Potential was classified as the fishery manager's ability to use restoration techniques, i.e. species removal, barrier construction, hatchery supplementation, special regulations, and habitat recovery (Rieman and Apperson 1989).

Genetic inventories in Idaho are limited; only the upper Priest Lake population has been genetically tested (Personal Communication, Dave Cross, Idaho Panhandle National Forest). Suspected pure (the drainage had no history of stocking of other trout) populations exist in 13% of their range with only 4% of the historic range considered strong and pure (Rieman and Apperson 1989).

Decline in westslope cutthroat trout abundance was attributed to habitat loss in 87% of the streams, while overfishing contributed to 47% of the decline. Competition was thought to affect 12% of the population decline and genetic introgression 15% (Rieman and Apperson 1989). Habitat degradation has negatively affected populations. Forest management, including but not limited to timber harvest,

road construction, mining, and grazing, is seen as the major contributor to habitat degradation (Rieman and Apperson 1989).

Montana

The historic range of westslope cutthroat trout in Montana is the upper Missouri River drainage and the headwaters of the Marias, Judith, Musselshell, and Milk rivers east of the Continental Divide, the South Saskatchewan drainage, and the upper Columbia River basin west of the Continental Divide.

Cutthroat trout were first recorded in 1805 by the Lewis and Clark expedition near the "Great Falls of the Missouri" (Behnke 1992). Trotter and Bisson (1988) reviewed early western explorers' journals and concluded that cutthroat trout were extremely abundant where they occurred.

Liknes and Graham (1988) summarized the status and management of westslope cutthroat and estimated that the species occupied 27% of its historic range in Montana. Biologists using the Montana Rivers Information System (MRIS) estimate that in Montana, westslope cutthroat trout occupy 19% of their historic range of 57,184 stream miles as derived from the 1:100k hydrography layer. Estimates were based upon the 1994 update of the database and historic occupancy assumed this subspecies occurred in all perennial streams, which may be an overestimate. Further refinement of this assumption is needed through record searches, interviews etc. to more realistically document historic range.

Westslope cutthroat trout populations in Montana are abundant in 2% of their historic range and would be considered viable (abundant and common) in 8% of their historic range. Of the remaining populations, 11% are abundant and 45% are considered viable. Northwestern Montana is considered the stronghold for genetically pure and strong populations. The distribution and abundance of this subspecies is continuing to decline across the state. Decline of westslope cutthroat trout populations is not a recent phenomenon; Hanzel (1959) concluded that this subspecies was restricted to headwater streams where they originally occurred and most populations were in streams above barriers.

In 1988, Liknes and Graham (1988) estimated that genetically pure populations were present in about 2.5% of the historic range and 9% of the current range. Currently, about 33% of the remaining 10,830 stream miles occupied by westslope cutthroat trout have have been electrophoretically sampled, of those tested, 59% are pure. In other words, about 20% of the current populations are known to be pure. Another 13% are suspected to be pure without potential introgression, but remain untested. A much higher proportion of pure populations have been tested because biologists have emphasized testing of those waters where pure populations are suspected.

Biologists with the Forest Service, Bureau of Land Management, and Montana Department of Fish, Wildlife, and Parks are conducting a broad scale assessment on upper Missouri River basin westslope cutthroat populations. They have found that westslope cutthroat trout occupy about 7% of their historic range while pure populations exist in about 1% of their historic range. As a general rule, populations have been isolated into small, fragmented headwater streams (Brad Shepard, Montana Fish, Wildlife and Parks, personal communication).

Reasons for decline of westslope cutthroat trout populations in Montana have not been quantified, however, biologists identified factors similar to those in Idaho. Liknes and Graham (1988) feared that hybridization, mainly with rainbow trout, was the greatest factor, but habitat degradation, angling, and competition also contribute to decline. Table 1 presents westslope cutthroat range, abundance, and genetic analysis in Montana.

Oregon

Information on westslope cutthroat trout in Oregon was obtained through surveys completed by Errol Claire, Oregon Department of Fish and Wildlife. Westslope cutthroat trout occur in small disjunct populations in the John Day River Basin. There are 23 populations confined to the headwaters in the upper John Day River consisting of about 20 tributaries in the upper mainstem and several tributaries in the North Fork John Day River. Dr. Robert Behnke, Colorado State University, has meristically determined the upper mainstem population to be westslope cutthroat trout in 1980 based upon 24 fish from 8 streams (Errol Claire, Oregon Department of Fish and Wildlife, personal communication).

Historically, westslope cutthroat trout occupied about 10% (currently 1%) of North Fork John Day River drainage and are now considered at risk and declining due to the vulnerability of its shrinking habitat and critical habitat requirements. The upper mainstem population is also considered at risk for similar reasons but is more common, historically occupying 25% (currently 5%) of the drainage (Errol Claire, Oregon Department of Fish and Wildlife, personal communication). Westslope cutthroat trout are believed to have occupied 179 miles in the two drainages and currently occupy 73 miles or 41% of their historic habitat (Kostow et al. 1994).

Grazing, timber harvest, and irrigation diversions have degraded habitat and restricted these populations into small headwaters. Most populations are on private land. The trend in abundance and distribution could stabilize given new forest management, habitat restoration efforts and ecosystem restoration (Errol Claire, Oregon Department of Fish and Wildlife, personal communication).

Washington

Washington has several disjunct populations of westslope cutthroat trout in the Yakima, Methow, Lake Chelan, Entiat, and Wenatchee rivers (Behnke 1992). Endemic cutthroat trout are considered to be glacial relics from the early Pleistocene when post-glacial flooding established populations above barrier falls which excluded competing species such as rainbow trout and steelhead (Mullan et al. 1992). Cold water temperatures below hanging valleys, for example in the West Fork Methow River, are thought to favor cutthroat trout and exclude competing species that are capable of displacing cutthroat trout (Ken Williams, Washington Department of Wildlife, personal communication).

The Washington River Information System currently lists 1,557 stream miles occupied by westslope cutthroat trout. The upper Yakima, Wenatchee, Methow, Lake Chelan, and Pend Oreille drainages, respectively, have the highest occupancy. But a high percentage are probably the result of introductions (Ken Williams, Washington Department of Wildlife, personal communication). Stocking programs for westslope cutthroat trout in Washington date back to 1903; the brood sources probably came from Lake Chelan or the Wenatchee River drainage (Ken Williams, Washington Department of Wildlife, personal communication). Declines in Lake Chelan adfluvial cutthroat trout populations were noted as early as the 1920's as anglers could catch "native cutthroat" with regularity only in headwater streams of the Stehekin River. A 10 fish sample from such a stream, Flat Creek, in 1982 was confirmed as pure westslope cutthroat by Dr. Behnke. However, much of the historic distribution of endemic westslope cutthroat trout in Washington is clouded because of extensive stocking of alpine lakes and the subsequent colonization of tributary streams.

In 1992 and 1993, samples of trout were taken from the Methow, Wenatchee, and Entiat river watersheds to determine the distribution of pure and hybrid trout populations in the mid-Columbia River area (Proebstel et al. 1995). In the Methow watershed, a total of 84 sites were sampled within the 32 different tributaries and 4 lakes visited. In the Wenatchee watershed, 41 sites were sampled

within 28 tributaries, while in the Entiat watershed, 17 sites within 11 different streams were sampled. Westslope cutthroat trout were found in 19, 17, and 3 of these sites in the Methow, Wenatchee, and Entiat watersheds, respectively. Among these 9, 10, and 1 of these sites for the Methow, Wenatchee, and Entiat watersheds, respectively, contained "pure" (100% confidence in identification) or "essentially pure" (near 100% confidence; one + morphometric feature may be questionable) westslope cutthroat trout. In the remaining westslope cutthroat trout sites, specimens were questionable; morphometric characters suggest historic gene flow with other cutthroat trout races or, perhaps, rainbow trout. Populations in these drainages are mostly on National Forest System lands.

The status of populations generally remain unknown with the greatest threat being anglers in highly accessible streams (Larry Brown, Washington Department of Wildlife, personal communication). Other threats such as habitat loss, competition, and hybridization exist but remain unquantified.

Wyoming

The range of westslope cutthroat trout extends into the headwaters of the Madison and Gallatin rivers within Yellowstone National Park. Colonization was precluded into the Gibbon and Firehole rivers due to barrier falls. Biologists with the United States Fish and Wildlife Service working within the park estimate that westslope cutthroat trout may have occupied between 12-15 streams in the headwaters of these rivers. Currently, about 6 populations remain with each having some degree of hybridization with Yellowstone cutthroat trout and/or rainbow trout. Only two tributary streams contain populations with genetic purity greater than 98% based upon electrophoretic analysis (Personal Communication, Dan Mahoney and Lynn Kaeding, United States Fish and Wildlife Service). Reasons for decline are competition and hybridization with exotic species, particularly brown trout, rainbow trout, brook trout, and Yellowstone trout. Yellowstone trout were also introduced into the Madison and Gallatin rivers which are outside their native range in Yellowstone National Park.

TRENDS

As early as 1959, Hanzel (1959) documented in Montana that westslope cutthroat trout were restricted to headwater streams with pure populations being retained above barriers. Westslope cutthroat trout were originally on the United States Fish and Wildlife Service's (USFWS) "Red Book" of threatened and endangered species from 1966- 1972 but were dropped from the list with the passage of the Endangered Species Act in 1973 due to questions concerning classification (Roscoe 1974). The USFWS previously classified westslope cutthroat trout as a Category 2 species (listing is possibly appropriate, but persuasive data on biological vulnerability and threat are not currently available to support proposed rules) prior to the deletion of Category 2 species from the candidate list on February 28, 1996 (61 FR 7596).

Reasons for decline were noted early. Hanzel (1959) listed: stream habitat changes, competition with exotic species and hybridization with rainbow trout as major factors of decline. In the 1970 T,E, & S supplement to the Forest Service Manual Region 1, the Forest Service identified habitat degradation and increased fishing pressure as factors of decline. They cited "road construction as perhaps the most serious source of damage from man's activities". Not only as a result of sediment but increased temperatures, improper culvert installations, and increased angler access. Three decades later, populations continue to decline from competition and hybridization with exotic species, habitat loss and degradation, and continued fishing pressure.

Presently, Washington was the only state that indicated populations appear stable where known but status of numerous populations remain unknown. As a whole, trend is declining throughout this

subspecies range but has not been quantified. The Montana and Idaho River Information Systems are lacking information for "population status" screens. Oregon noted that trap counts in 1992 from diversion screenings in the John Day River were 42% of the 10 year average (Kostow et al. 1994).

The Interior Columbia River Basin Project (ICRBP) is currently assessing the status of fish taxa throughout the Interior Columbia River Basin. Westslope cutthroat trout was selected as a key taxa and their present distribution is being described across the assessment area. The ICRBP (Draft Report) estimates that westslope cutthroat occupy 74% of their historic range but remain strong in only 13% of the historic range. Estimates were derived by status calls from fishery biologists for each 6th order Hydrologic Unit Code across the assessment area.

Resident westslope cutthroat trout have been pushed into fragmented headwater habitats where small population size increases the risk of extinction (Rieman et al. 1993). Migratory forms appear to have suffered the greatest decline. Flathead, Priest, Pend Oreille, and Coeur d' Alene lakes are the only large, natural lakes within the range of westslope cutthroat trout. Losses have not been quantified, but numbers are down. Coeur d' Alene Lake, perhaps has the strongest remaining population which may be reflective of lake trout being absent (Dave Cross, Idaho Panhandle National Forest, personal communication). The maintenance of migratory forms is important in providing genetic exchange and for re-colonizing habitats after local extinctions.

Westslope cutthroat trout populations appear to remain strong in roadless areas, wilderness areas, and Glacier National Park (Liknes and Graham 1988; Marnell 1988; Rieman and Apperson 1989), therefore it is readily apparent that human influence has greatly affected this subspecies.

MANAGEMENT IMPLICATIONS

Westslope cutthroat trout have evolved in relatively sterile environments. It is obvious that these high-quality waters that were once dominated by native fishes are declining. Native fish represent important intrinsic values that cannot be recovered when lost. If this natural diversity is to be retained, protection and restoration measures should not only focus on westslope cutthroat trout but on native species assemblages, including amphibians and invertebrates. Protection and restoration of aquatic assemblages will also need to focus on terrestrial habitats as the biotas are connected.

Protection needs to focus on the remaining high-quality habitats, primarily those in roadless and wilderness areas. Preserve designs should consider: minimum population size to prevent losses from stochastic, demographic, and genetic events; distribution and replication of preserves to guard against catastrophic events; habitat and species diversity, and connectivity between preserves to promote genetic exchange while avoiding isolation. Protection of headwater areas will be essential in maintaining water quality. Protection should also focus on maintaining genetic integrity and diversity outside roadless and wilderness areas by safeguarding genetically pure populations against contamination and loss. Lastly, construction of barriers to prevent exotic species contamination may be a tool. However, population size and effects of isolation should be considered and their risks evaluated.

Restoration will focus on rehabilitating degraded watersheds or removing undesirable non-native fishes. Many westslope cutthroat populations are isolated, where possible restoration should attempt to re-establish connections between isolated populations which will allow for natural recolonization in the event of catastrophies. Larger preserves that combine pristine habitats with restored habitats will be more resilient to natural disturbances. Restored watersheds will play a crucial role in any conservation strategy.

Identification and assessment of these watersheds is critical to beginning any conservation strategy. The future of westslope cutthroat and many other aquatic organisms rests upon our ability to manage these watersheds, many are on Forest Service land. Our actions today can provide future generations the opportunity to enjoy native fishes and other aquatic organisms in intact, functioning ecosystems.

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Table 1. Summary of Idaho and Montana River Information Systems (miles) for westslope cutthroat trout in Idaho and Montana by state (table modified from Rieman and Apperson, 1989).

HISTORIC RANGE

State	Adfluvial	Fluvial	Resident	Unknown
Idaho	1071	8837		1429
Montana		444*	9344	1043

ABUNDANCE

State	Strong/Abundant	Depressed/ Common	Remnant/ Uncommon	Rare	Absent	Unknown
Idaho	1120	2388	2708		1774	3520
Montana	1226	3605	2245	1269	46414	2427

GENETIC INTEGRITY

State	Documented		Suspected		Unknown
	Pure	Introgression	Pure	Introgression	
Idaho	52	7	1331	4245	4273
Montana	2150	1475	1366	3475	2365

* Reflects adfluvial and fluvial forms.

Chapter 2

Yellowstone Cutthroat Trout
Oncorhynchus clarki bouvieri

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INTRODUCTION

The information contained in this status review focuses upon Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*), a principle subspecies of cutthroat trout that historically occupied the upper portion of the Snake River, within the Columbia River basin, and the upper Yellowstone River, within the Missouri River basin. This subspecies of cutthroat trout along with westslope cutthroat (*O. c. lewisi*), Lahontan cutthroat (*O. c. henshawi*), Bonneville cutthroat (*O. c. utah*), Paiute cutthroat (*O. c. seleniris*), Colorado River cutthroat (*O. c. pleuriticus*), Greenback cutthroat (*O. c. stomias*), Rio Grande cutthroat (*O. c. virginalis*), and Yellowfin cutthroat (*O. c. macdonaldi*) were the primary trout that occupied the lakes and streams of the western United States (Behnke 1992). In addition to these taxonomically acknowledged subspecies, there are other cutthroat forms (i.e. finespotted Snake River cutthroat, Humboldt cutthroat, Alvord cutthroat and Whitehorse cutthroat) which inhabited specific locations and exhibited unique phenotypic characteristics (Behnke, 1979 and 1992).

General concern for the well being of these native trout species has been elevated as a result of recent status assessments (Williams et al. 1989 and Warren and Burr 1994). These status reports pointed to a dramatic decline in the status of many freshwater fish species with as many as 364 freshwater fish (about one-third of the American native freshwater fishes) identified as endangered, threatened or of special concern (Williams et al. 1989). The situation is particularly bleak within the western states (Warren and Burr 1994) which have a proportionately higher percentage of imperiled native species. Western trout (Behnke 1976) and salmon (Nehlsen et al. 1991) have suffered catastrophic declines in abundance due to essentially similar factors (e.g. exotic species introduction, habitat degradation and over harvest).

Concern for the status of western cutthroat prompted the Forest Service to initiate Habitat Conservation Assessments (HCA) for many interior cutthroat trout subspecies. The information contained in this HCA will focus on Yellowstone cutthroat trout (including the fine spotted cutthroat of the upper Snake River). The goal associated with this Yellowstone cutthroat trout HCA is to provide information linked to habitat conditions necessary to assure the long term survival of both large spotted and fine spotted forms. In addition, population status is addressed and related to habitat and species management within the historic range of the Yellowstone cutthroat trout subspecies.

ORIGINS AND TAXONOMIC THEORY

While it is not the intent of this HCA to provide detailed documentation of phylogeny and prehistoric zoogeography of Yellowstone cutthroat trout, it is important to review theory represented in the most recent work on native western trout (Behnke 1992). For an indepth discussion of the genesis of native western trout, including Yellowstone cutthroat trout, the reader should refer directly to Behnke's monograph. Phylogenetic and zoogeography theory supports the concept that, while evolutionary sequences leading to present cutthroat trout species and subspecies originated in the mid-Pleistocene era (more than a million years ago), most historical and prehistorical distributions were determined by events occurring in the last glacial and post-glacial periods (about 70,000 years ago to the present, Behnke 1992). For the purpose of this assessment, reference to the prehistoric status addresses conditions existing before the presence of white explorers (prior to 1800 AD) within the Yellowstone cutthroat distributional area (Figure 1.). Reference to the historic status addresses conditions occurring during and subsequent to the exploration and settlement of the western Rocky Mountains by early white explorers (after 1800).

Yellowstone cutthroat trout became isolated in the headwaters of the Snake River following creation of Shoshone Falls (between 30,000 and 60,000 years ago) and in two distinct areas of the lower Columbia River basin (Waha Lake, Idaho and Crab Creek, Washington)(Behnke 1979 and 1992). Behnke (1992) also presents the most logical method of movement between the Snake River and Yellowstone River drainages following the last glacial period (about 8,000 years ago). This headwater transfer allowed for movement and expansion of Yellowstone cutthroat trout into suitable habitats east of the Continental divide within the Yellowstone River drainage (Behnke 1979 and 1992).

During the period of time associated with historic exploration and settlement (1800 to 1900) of the West, cutthroat trout could be found in essentially the entire Snake River drainage above Shoshone Falls to the headwaters located within the Teton Wilderness area of Bridger-Teton National Forest and Yellowstone National Park (Rollins 1935; Jordon 1891; Evermann 1891; Gilbert and Evermann 1894). Even though the earliest explorations were linked to the fur trade, many diaries associated with these expeditions mentioned fish and specifically trout (Trotter and Bisson 1988). Robert Stuart, an early explorer of the upper Snake River in 1812, maintained a diary which mentioned eating trout taken from Marsh Creek, South Fork of the Snake and the Hoback River (Rollins, 1935). During the late 1800's, several scientific expeditions directed by the U.S. Fish Commission, focused attention on fishery conditions existing within the upper Snake and Yellowstone River basins. Both the Jordan (1889) expedition and the Evermann expedition (1891) visited portions of the upper Snake River drainage. The Gilbert and Evermann expedition, of 1892 and 1893, not only returned to sites within the upper portion of the Snake River drainage, they visited the Snake River between Shoshone Falls and Idaho Falls, including three tributary streams in that vicinity. Although not mentioned by early naturalists, the Snake River and its tributaries associated with Jackson Lake along with the mainstem Snake River and most tributaries downstream to the present Palisades Reservoir supported cutthroat having a unique spotting pattern characterized by a profusion of very small spots covering most of the body. They are referred to as "finespotted Snake River Cutthroat trout" and have the potential to represent a separate subspecies (Behnke 1979). Continued genetic comparison (Loudenslager and Kitchin 1979; Leary et al. 1987; Allendorf and Leary 1988) of the two cutthroat forms has not provided definitive proof that would lead to total acceptance that the "finespotted Snake River cutthroat" is indeed a separate subspecies. The fact that most early naturalists (David Starr Jordan being the exception) did not acknowledge the presence of the "finespotted" cutthroat form on their visits to the Snake River above Jackson Lake and within the Two Ocean Pass area is somewhat surprising given the tendency of the time to classify organisms based on outward appearance. The spotting pattern that is so noticeable at present was either inadvertently overlooked or deemed not important. Jordan (1891) acknowledges a difference in spot size and pattern between fish in Heart Lake (upper Snake

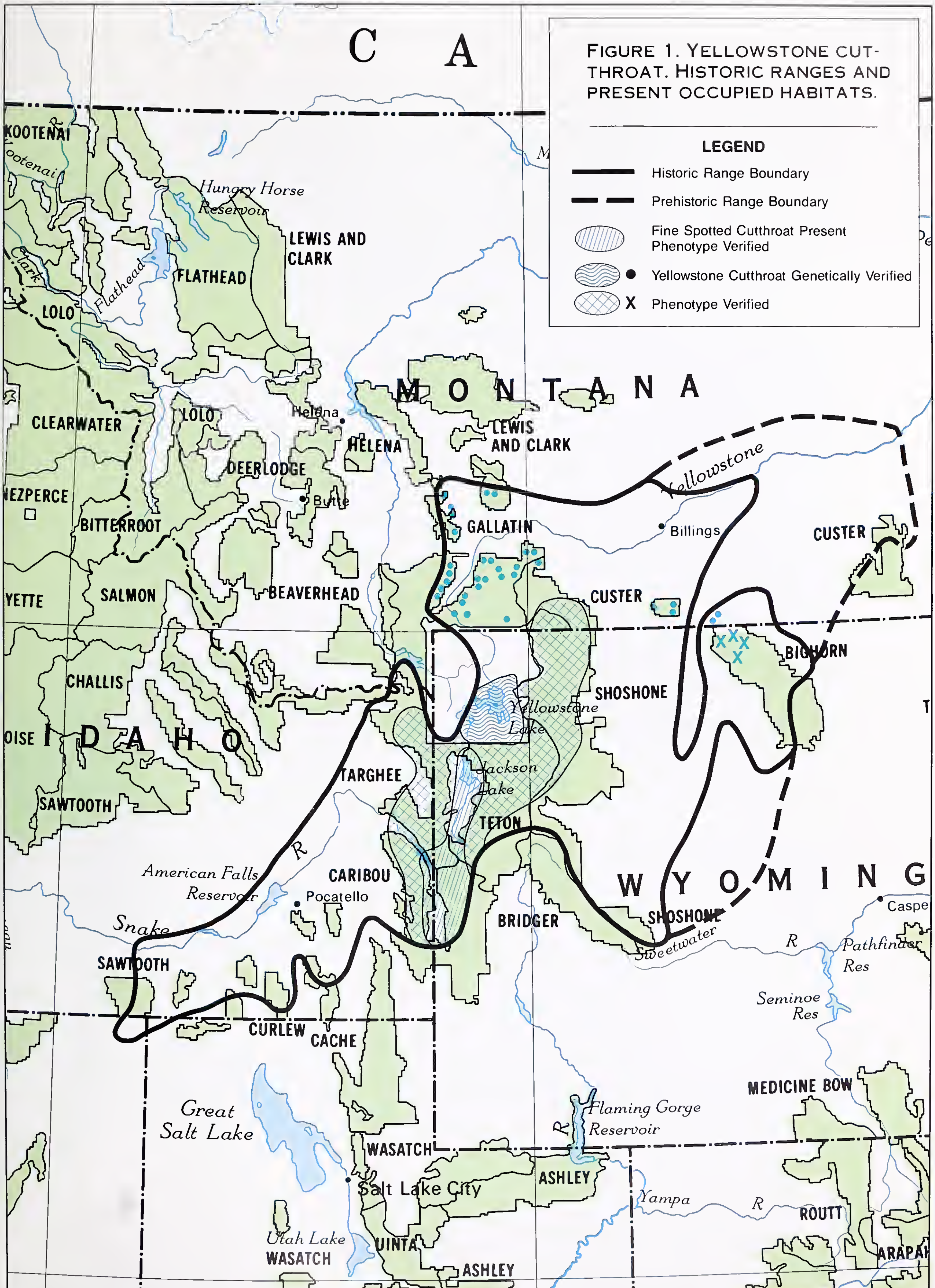
FIGURE 1. YELLOWSTONE CUTTHROAT. HISTORIC RANGES AND PRESENT OCCUPIED HABITATS.
LEGEND
Historic Range Boundary
Prehistoric Range Boundary
Fine Spotted Cutthroat Present Phenotype Verified
Yellowstone Cutthroat Genetically Verified
X Phenotype Verified
MONTANA
IDAHO
WYOMING
KOOTENAI
FLATHEAD
LEWIS AND CLARK
LOLO
CLEARWATER
HELENA
DEERLODGE
BITTERROOT
SALMON
BEAVERHEAD
GALLATIN
CUSTER
SHOSHONE
BIGHORN
CHALLIS
TARGHEE
SAWTOOTH
TETON
CARIBOU
BRIDGER
CURLEW
CACHE
WASATCH
ASHLEY
UINTA
MEDICINE BOW
ROUTT
Helena
Butte
Billings
Pocatello
Casper
Salt Lake City
Yellowstone Lake
Jackson Lake
Great Salt Lake
Utah Lake
Hungry Horse Reservoir
American Falls Reservoir
Flaming Gorge Reservoir
Pathfinder Res
Seminoe Res
Yellowstone
Snake R
Sweetwater R
Yampa R
Flathead
Clark

River) and those in Yellowstone Lake but does not raise the possibility of these fish being different species. While Behnke (1992) continues to believe that the evolutionary and ecological reality of the existence of the finespotted cutthroat warrants subspecies status, he also acknowledges that the difference in spotting pattern might be the result of two alleles occurring at one gene locus as shown for brown trout (Skaala and Jorstad 1988). It is anticipated that continued research into the genetic and taxonomic status of both the finespotted and largespotted forms will continue and there is the possibility that more definitive information will bring the discussion to a close, one way or the other. For the purposes of this assessment, both the large and finespotted forms will be treated as Yellowstone cutthroat trout with the information on the two cutthroat forms being presented both in combination and separately depending upon the type of information reported.

Within the Yellowstone River drainage, cutthroat trout occupied a substantial number of headwater streams as indicated in both Jordan's (1891) and Evermann's (1891) reports which provide information from areas in and adjacent to Yellowstone National Park. Jordan paid particular attention to the many falls within the Park which had served as barriers to fish movement and projected that the area above the falls, in aggregate, would equal 1,500 square miles. Actual extent of cutthroat distribution within the lower portions of the Yellowstone River drainage was not well documented. The fact that cutthroat trout were documented in the upper reaches of the Tongue River drainage (Evermann and Cox 1894 and Willert 1986) and not in the lower portions of the Tongue and other tributaries or even the lower Mainstem Yellowstone (Coues 1893 as noted in Evermann and Cox 1894) leads one to ponder on just how much of the lower Yellowstone River drainage was actually occupied at the time of early exploration and settlement. From a prehistoric perspective, it is very possible that there were periods of time when climatic conditions (e.g. cooler and wetter periods) would have allowed for population expansion down to and including the Tongue River. During such conditions it would be expected that the entire Bighorn River drainage, Yellowstone River, and Tongue River could have been suitable for cutthroat trout. It is also possible that cutthroat located in the upper Tongue River were a result from a basin transfer from the Little Bighorn River basin. Both options are feasible given climatic variability and topographic characteristics. From a historical perspective and for the purposes of this assessment, Yellowstone cutthroat trout distributional range will not include the lower portion of the Tongue and mainstem Bighorn River drainages. In addition, the historical range will not include that portion of the mainstem Yellowstone River from just above the confluence of the Bighorn River downstream, including all tributary streams.

ASSESSMENT METHODS

The basic intent of this assessment effort was to provide a more definitive appraisal of current distribution, condition and abundance of Yellowstone cutthroat trout within their historic range with specific attention focused on State and Forest Service administrative jurisdictions. To accomplish this, information associated with historic and current distribution and condition characteristics was obtained from biologists from State Wildlife Agencies and various National Forests. For the area within each State, these knowledgeable individuals completed localized assessment questionnaires. In addition to information associated with distribution, the questionnaires also addressed factors related to population well-being and habitat condition. The information was collected on a sub-basin basis with the assessment boundaries being determined by the local biologists. Each sub-basin contained one or more drainages or sections of drainages. For each of these assessment areas, a standard set of questions was addressed and the most pertinent responses were recorded. It should be noted that quality and precision of the information collected represent, to a large degree, best professional knowledge of the biologists based upon specific experience and knowledge of individual streams and populations. In some instances, data bases were used to provide the needed information.

Two planning meetings associated with the assessment were held prior to completion of the questionnaires. The first meeting involved individuals knowledgeable with the Snake River drainage; the second meeting involved individuals with specific knowledge of the Yellowstone River drainage. At these meetings the basic purpose of the assessment was discussed and the questionnaires were refined. Projected time frames for completion of questionnaires were also identified. In addition to information derived from the questionnaires, attempts were made to secure and validate historical information which made reference to occurrence of cutthroat trout.

RESULTS AND DISCUSSION

Several reports have alluded to the current status of Yellowstone cutthroat trout and other native trouts in the west (Hanzel 1959; Behnke and Zarn 1976; Hadley 1984; Thurow et al. 1988; Varley and Gresswell 1988; Behnke 1979 and 1992). In a number of these appraisals (Behnke 1979 and 1992; Varley and Gresswell 1988), Yellowstone cutthroat trout were viewed as doing surprisingly well when compared to other cutthroat subspecies. Behnke's (1979 and 1992) assessments were associated mainly with biomass within Yellowstone National Park and the headwaters of the Yellowstone River and not to distribution or preservation of diversity. Varley and Gresswell (1988) provided a quasi-quantitative assessment of current Yellowstone cutthroat trout status (85% occupancy of native lake environments; 10% occupancy of original stream habitat) but they provided no information on how the quantification was derived. Nor did they elaborate on how they arrived at their statements related to success, especially for riverine populations. Thurow et al. (1988) provided an assessment of cutthroat trout status within the Idaho portion of the Snake River drainage but again the assessment was largely qualitative in nature. Within Montana, Hadley (1984) prepared a status report for Montana Department of Fish, Wildlife and Parks utilizing Yellowstone cutthroat information available in the state's computerized database. Hadley's summary assessment projected an 8 percent occupancy rate for pure strain Yellowstone cutthroat trout in the Yellowstone River drainage.

This status assessment is intended to be an extension of these earlier efforts. Current information is based on conditions occurring within the entire range of Yellowstone cutthroat, including the finespotted form that occupies a portion of the Snake River drainage. To facilitate reporting and discussion of the status information, findings will be presented by State and to some extent by National Forest.

Idaho

The assessment area within Idaho included the Snake River drainage from Shoshone Falls upstream to the border between Idaho and Wyoming. Included within this area was the mainstem Snake River, the major tributaries and numerous smaller tributary streams. Three National Forests (Sawtooth, Caribou and Targhee NF's) occur within portions of this area. In total, twenty one (21) sub-basin areas (Table 1) were established and a questionnaire for each was completed. The mainstem Snake River, between Shoshone Falls and the confluence of the Henry's Fork and the South Fork of the Snake (also referred to as the Snake River) was divided into two sub-basin units; one section of stream between Shoshone Falls and American Falls and another section between American Falls to the confluence of the Henry's Fork and the South Fork Snake River. In addition, several of the major tributary drainages, within this section of the Snake River (Goose Creek, Raft River, Bannock Creek, Portneuf River, Blackfoot River and Willow Creek) were treated as separate analysis units. The Henry's Fork of the Snake River was divided into a section upstream from the confluence with the South Fork of the Snake to the town of St. Anthony along with another section extending from St. Anthony to Henry's Lake. Within this portion of the drainage several major tributaries (Teton River, Falls River, Warm River, Buffalo River) were identified as separate sub-basins as was the drainage

area above Henry's Lake. The South Fork of the Snake River and tributaries, from the confluence with the Henry's Fork to Palisades Reservoir, was treated as a sub-basin. Several drainages that flow into the Salt River originate in Idaho (e.g. Jackknife, Tincup, Stump and Crow Creeks). Those portions of these drainages, in Idaho, were treated as separate analysis areas. The lower portions of these sub-basins are bisected by the State boundary between Idaho and Wyoming.

The amount of historic Yellowstone cutthroat trout riverine habitat within Idaho was estimated at 3,797 miles (Table 1). This amount included approximately 210 stream miles associated with tributaries to the Salt River and South Fork of Snake River that are occupied by the "finespotted Snake River" form. Also included was a minor amount (58 miles) of stream habitat associated with the Goose Creek and Raft River drainages located in Nevada and Utah (Personal communications with Mr. Gene Weller, Nevada Department of Wildlife and Mr. Kent Summers, Utah Division of Wildlife Resources). In addition to the riverine environments, 3 lakes (Henry's Lake and the two Palisades Lakes) were identified as being historically occupied. There is little historical information that quantifies trout abundance; most historic references provide an indication that trout were very abundant in upper stream reaches and common in lower areas (Gilbert and Evermann 1892; Rollins 1935).

This current assessment (Table 1) indicates that approximately 1,622 miles of streams are presently inhabited by Yellowstone cutthroat trout (there was some uncertainty about the current status that precluded a determination in four of the sub-basins). Based on this information, approximately 43% of the historic habitat was felt to be currently occupied by Yellowstone cutthroat trout. Even though this occupancy value appears to be relatively high, caution should be applied before arriving at any final conclusions. Only a minor amount of genetic verification has occurred to date and there is a possibility that many populations have been influenced by rainbow trout hybridization. Visual, including meristic, determinations often preclude detection of rainbow trout contamination. The cutthroat trout in the headwater portion of Goose Creek, which enters the Snake River immediately above Shoshone Falls, has been shown through meristic evaluation (Personal Communication, Robert Behnke, Colorado State University)) and electrophoretic analysis (Personal communication, Gene Weller, Nevada Department Fish and Game) to be genetically pure. Other populations that have been electrophoretically verified, within the lower portion of the Snake River drainage, include Eight mile Creek (tributary to Raft River) and the headwater tributaries to the Blackfoot River. Exotic trout species were present in 19 sub-basins and these species were identified as being a potential threat in 16 sub-basins (Table 2). Rainbow trout were identified as being present in all 16 sub-basins and hybridization is a probable condition (Thurow 1988). There were nine (9) sub-basin identified as supporting populations of Yellowstone cutthroat of unknown status. With the exception of drainages reported by Thurow et al. (1988) and several that were specifically addressed in the questionnaires, little quantification of population status (Table 2) exists and most of the information is based on qualitative appraisals of population health.

Historical references relating to habitat condition, within the Idaho portion of the Snake River, are limited and largely qualitative (Gilbert and Evermann 1892). Gilbert and Evermann's description of habitat condition included temperature and substrate observations for both the Ross (probably Blackfoot River) and the Portneuf Rivers near their confluence with the Snake. For both streams, the summer afternoon water temperatures were observed in the mid to low 70's (F) and stream substrates had high levels of mud (probably sands and silts) along with gravels. Mink Creek, a tributary to the Portneuf River, was also described as having an afternoon water temperature of 59 F and a sand and gravel substrate. For all three streams, comments were made about dense growths of willows directly on the banks and within adjacent riparian areas. Trout were noted as being common in all three streams supporting the conclusion that habitat was in good condition and that occupancy was probable for the entire length of these streams. It is logical to conclude that other tributaries to the Snake also provided suitable habitat of similar quality characteristics. Current habitat assessment

indicates that a substantial number of the sub-basins have stream habitat in good to extremely degraded condition (Table 3). There was also a significant level of uncertainty relative to the trend in condition (Table 4). Specific comments pointed to channel dewatering, changes to channel morphology and increased sediment as major factors influencing habitat.

The status of Yellowstone cutthroat trout within National Forest lands in Idaho indicates a somewhat higher (53%) occupancy (Table 1). This assessment did not specify population life history and abundance characteristics for Yellowstone cutthroat trout residing in Forest habitats. There was, however, an effort to identify habitat status and factors contributing to current status (Tables 3 and 4). It is important to note that information contained in Tables 3 and 4 may at times seem inconsistent. For some sub-basins more than one condition and/or trend was identified and for other sub-basins condition and/or trend may have been omitted. The same is true for the information associated with factors linked to degradation and the land-use activities associated with those factors. There was also one instance where a sub-basin included two Forests. Of the 19 sub-basins which contained aquatic habitats on National Forests, 47% were identified as having good habitat condition with 37% having a fair rating and 16% having a poor habitat condition (Table 3). For the National Forests, in general, dewatering, changes in temperature, channel modification, limited large woody debris and sediment were viewed as the factors with greatest affect on habitat condition. The land-use that was identified as having the greatest influence was grazing followed by logging, road construction and mining. The Targhee National Forest had the highest proportion of sub-basins (7) with habitat rated as good (86%) and fair (43%). Habitat condition ratings for the Caribou National Forest sub-basins (10) included good (20%), fair (40%) and poor (20%). The Sawtooth National Forest had only three sub-basins with 33% rated as fair and 33% rated as poor. Each Forest had a somewhat different mix of factors and land-use activities which contributed to the condition ratings (Table 4). Channel modification and/or sediment were primarily associated with degraded condition and grazing was identified as the detracting land-use.

Wyoming

The assessment area included the Snake River drainage from the State boundary with Idaho upstream to the headwaters and the Yellowstone River from the State boundary with Montana upstream to the headwaters. Also included were the major tributaries (e.g. Clarks Fork of the Yellowstone, Bighorn River and Tongue River) that enter the mainstem Yellowstone River's middle section. Twenty five (25) sub-basin analysis units (Table 5) were established and a questionnaire was completed for each. The mainstem Snake River was divided into two analysis units; one section between Palisades Reservoir and Jackson Lake and another from Jackson Lake to the headwaters. In addition, most of the major tributaries (Salt River, Greys River, Hoback River, Gros Ventre River, Spread Creek, Buffalo Fork and Pacific Creek) were treated as separate analysis units. The Yellowstone River assessment included sub-basins within Yellowstone National Park including a sub-basin that extended from the north Park boundary to Yellowstone Falls and an analysis unit that extended from the Falls to the south Park boundary. The headwaters above the Park were treated as a separate assessment unit. The Clarks Fork of the Yellowstone River drainage was treated as a separate unit. Within the Bighorn River drainage there were 9 sub-basins and there were 3 within the Tongue River drainage.

The amount of historical Yellowstone cutthroat trout riverine habitat within Wyoming was estimated at 10,949 miles. This amount included approximately 1,569 miles of stream habitat that would have been occupied by the "fine spotted Snake River" form (Table 5). These mileage estimates are likely an over estimate resulting from the data base from which the information was taken. The particular data base used to provide the mileage information included all perennial streams including many headwater streams that likely would not support fish. Mileage information for the Clarks Fork of the Yellowstone was also included, even though, documentation indicates that the upper portion of the

drainage was fishless above barrier falls (Jordan (1891). Recent information collected within the Greybull River drainage indicates that there are approximately 99 miles of stream felt to support fish (personal communication, Carter Kruse, University of Wyoming). In addition to the riverine environments, 113 lakes (most notable being Yellowstone Lake) were identified as being historically occupied.

The Wyoming portion of the historic range, and specifically that portion of the range within and adjacent to Yellowstone National Park, has the most historical information relating to presence and relative abundance. Two of the earliest accounts are associated with explorations directed by John Jacob Astor as part of his involvement in the fur trade in the west. In 1810, Astor supported an expedition lead by Wilson Price Hunt which traveled through the upper portion of the Wind River drainage into the upper Snake River and then on to the lower Columbia River (Franchere 1973). Hunt's diary contained a reference to an abundance of "herring" in the Wind River and it is likely that these fish were either young cutthroat trout or mountain whitefish. Price also mentions the party's limited success to net trout from the upper Snake River drainage. A second expedition, lead by Robert Stuart in 1812, essentially back tracked on a portion of Hunt's travels (Rollins 1935). Stuart's daily account included reports of trout taken from the Portneuf drainage (Marsh Creek), Bear River Drainage (these trout would have been Bonneville cutthroat), the upper Snake River near Big Spring Creek and the Hoback River (although not specifically mentioned these were likely the "fine spotted" form). In 1864, an expedition under the leadership of Major John Owen and Jim Bridger entered the Bighorn drainage from the south in an effort to establish a travel route between the Oregon trail and Montana region (Seymour 1927). Owen's journal recounted the groups travels down the Bighorn River and the first mention of trout occurred when they encountered the Greybull River. A second record of trout was associated with the Shoshone River. Another example is the historical account of Lt. John Bourke, who was with General Crook's company in 1876 as they entered into the upper Tongue River drainage. Bourke's diary contains comments about a single harvest of 500 fish and an estimation that the 1550 troops had consumed between 10,000 to 15,000 trout during a three week period (Willert 1986). This same area was visited by Evermann and Cox in 1893 and the following observations were made.

> "Many persons were seen along the river fishing for trout. Taking everything into consideration, it would certainly be hard to find a more ideal trout stream. Small parties have reported as many as 800 fish taken with hook and line in a few days" (Evermann and Cox 1894).

Without exception, the early records of cutthroat trout, in and around Yellowstone National Park, refer to the populations as abundant to extremely abundant (Evermann 1891; Jordan 1891; Gilbert and Evermann 1894; Kendall 1914; Trotter and Bisson 1988).

There was considerable uncertainty regarding how much of the mainstem Bighorn and Tongue Rivers, within Wyoming, supported cutthroat trout. Early settlers (1870 to 1900) to the Bighorn basin near, Manderson, Wyoming report the presence of turtles, catfish and a fish they referred as "shad" (Personal communication, Mrs. Wanda Bond, Greybull, Wyoming). These fish referred to as "shad" may have been goldeye or even possibly freshwater drum. Mrs. Bond also said that her father indicated that trout were occasionally taken in the Bighorn River but she indicated that "if trout were what the families were interested in they would go to Shell Creek or some other smaller stream". Given that the mainstem Bighorn River as far up as Manderson, Wyoming supported fish and other aquatic species associated with warmer water, it is unlikely that cutthroat trout were anything but occasional visitors resulting from drift out of the tributaries. In discussing the matter with Mr. Ron McKnight, Wyoming Game and Fish Department, he felt that actual historic trout habitat probably extended downstream to somewhere between Worland and Thermopolis. Based on these reports, the main-

stem Bighorn River from the town of Kirby downstream was not considered as historical Yellowstone cutthroat habitat, even though cutthroat trout may have been present to a limited extent.

Approximately 4,624 miles of stream habitat, in Wyoming, are presently inhabited by Yellowstone cutthroat trout (Table 5). Here again the mileage estimates are likely inflated as a result of the information from the Bighorn and Clarks Fork basins and how that information was used. Included within the total are 1,751 miles of stream habitat occupied by the "fine spotted" form. The current extent of "fine spotted" Yellowstone cutthroat occupancy has actually increased as a result of stocking of hatchery reared fish into habitats outside of the "fine spot" range. Based on this information, approximately 42% of the historic habitat was felt to be currently occupied by Yellowstone cutthroat trout. Even though this occupancy value appears to be relatively high, caution should again be applied before arriving at any final conclusions. For most sub-basins, genetic integrity has been determined by meristic and/or visual techniques which have limited ability to detect hybridization with rainbow trout. Coupled with this is the acknowledgement that 96% of the sub-basins have exotic species present, including rainbow trout, or they have received past plants of rainbow trout (Table 6). Until a more detailed assessment of genetic purity is undertaken it is probable that current occupancy estimates are too high. The origins of existing populations were identified as being remnant of historic populations or they were linked to recent hatchery introductions, as in the case of "fine spotted" Yellowstone cutthroat trout. Within the sub-basin areas, the majority of cutthroat trout populations were determined to be secure and stable (Table 6), with a lesser number of sub-basins having populations described as being stable but at risk. Even though twenty four of the sub-basins indicated the presence of exotic trout species, only twelve indicated a concern that exotic species could be a threat to cutthroat trout.

Historical references of aquatic habitat conditions, within Wyoming, are limited to information supplied by naturalist visits directed by the U.S. Commission of Fish and Fisheries (Jordan 1891, Evermann 1891, Gilbert and Evermann 1894). These early accounts of habitat condition were usually qualitative, but they provide a reference point for comparison. Jordan (1891) alluded to the numerous falls, within the Yellowstone National Park area, which maintained a substantial amount of area (estimated at 1500 sq. mi.) in a fishless condition. Jordan also mentioned the influence of thermal features on fish and water quality. Evermann's (1891) habitat descriptions of the Snake River above Jackson Lake (President's Camp) and within the Yellowstone River drainage included references to water temperatures, water clarity , substrate composition and, in some instances, width and depth characteristics. Gilbert and Evermann (1894) revisited the upper Snake River in 1892 and they provided similar qualitative observations. For all habitats supporting trout, historic abundance observations would likely correlate with excellent habitat.

Assessment of current habitat conditions in Wyoming indicates a slightly different picture with only a minor portion of the sub-basins reflecting excellent habitat condition. A substantial number of the sub-basins reflected conditions ranging from good to poor (Table 7). Trends associated with current habitat condition were generally considered to be stable for both the habitats on National Forest administered land and those found in other ownership. The factors affecting aquatic habitat quality and some of the associated land uses are identified in Table 8. It is important to note that information contained in Tables 7 and 8 may at times seem inconsistent. For some sub-basins more than one condition and/or trend was identified and for other sub-basins condition and/or trend may have been omitted. The same is true for the information associated with factors linked to degradation and the land-use activities associated with those factors. Grazing, mining, logging, road construction and agriculture were the land-uses identified as contributing to channel dewatering, channel modification, limited large wood and increased sediment.

The status of Yellowstone cutthroat in National Forests, in Wyoming, indicates a somewhat higher (55%) occupancy value for National Forest habitats (Table 5). No attempt was made to specify population life history and abundance characteristics for Yellowstone cutthroat trout residing in Forest habitats. There was, however, an effort to identify habitat condition and the factors associated with condition (Tables 7 and 8). Of the 23 sub-basins which contained aquatic habitats on National Forests, 74% were considered to have good cutthroat habitat with 26% being viewed as fair. The majority of this habitat was viewed as having a stable trend. Habitat on the Bridger Teton National Forest was essentially viewed as being in good condition and the trend was identified as stable. Limited woody debris, elevated sediment levels, channel modification and channel dewatering were the factors identified and grazing was the most significant land-use. Habitat within the Shoshone and Bighorn National Forest sub-basins was equally split between good (50% of sub-basins) and fair (50%). Four factors (channel dewatering/hydrograph alteration, channel modification, limited woody debris and elevated sediment) associated with habitat condition were identified in all Shoshone National Forest sub-basins. Grazing, mining and logging were the land-uses linked to degraded habitat condition. On the Bighorn National Forest, there was considerable uncertainty regarding the factors influencing habitat condition. Only 50% of the sub-basins reported on factors contributing to habitat condition. Grazing and road construction were viewed as the primary land-uses contributing to increased sediment (Table 8).

Montana

The assessment area within Montana included the mainstem Yellowstone River and tributaries downstream from the Wyoming-Montana state line. Included were those portions of the Clarks Fork of the Yellowstone River occurring within Montana. In total, thirteen sub-basin areas (Table 9) were established and questionnaires completed. In contrast to previous assessments and evaluations (Behnke 1979 and 1992, Hadley 1984, Varley and Gresswell 1992) which identified historic habitat within the entire Yellowstone River drainage downstream to and including the Tongue River, this assessment did not include the mainstem Yellowstone River downstream from about where the Bighorn River enters; nor does it include the lower portion of the mainstem Bighorn River or Tongue River drainage below the State line as part of the historic range of Yellowstone cutthroat trout. The rationale for not including the lower mainstem Yellowstone River was based, in part, on observations made during William Clark's (Coues 1893 as related in Evermann and Cox 1894) return trip along the Yellowstone River. Clark's diary mentioned that "some catfish and soft-shelled turtles were precured" near mouth of Tongue River. This observation indicates that habitat characteristics not conducive to supporting trout. Present day fish sampling within this section of the mainstem Yellowstone River also substantiates that habitat conditions are not favorable for the maintenance of trout populations (Personal Communications, Phil Stewart, Montana Department of Fish, Wildlife and Parks). Another source of information that provides an understanding of Yellowstone cutthroat distribution is from the diary of Lt. John Bourke (Willert 1986). Bourke's diary provides detailed daily accounts of conditions and circumstances associated with General Crooks (1876) travels in the Tongue and Rosebud drainages. Bourke made several notations regarding the poor quality of food that soldiers were required to eat. Upon arriving at the Tongue River near the present city of Sheridan, Wyoming, Bourke goes to great lengths to express his excitement and gratitude for having trout to supplement field rations. After leaving the upper Tongue, the Wyoming Company under General Crook's leadership followed the Tongue River downstream well into Montana and then crossed over into the Rosebud Creek drainage which enters the Yellowstone above the Tongue River. Bourke's account again addresses the poor quality of field rations but there is no mention of fish being part of their diet. The fact that fish and specifically trout were not mentioned is probably a function that they were no longer available. A final indication that trout populations did not reside in the lower portions of these drainages comes from family accounts of early settlers of Lodge Grass, Montana which indicated that

trout were taken from the Little Bighorn drainage upstream of the town but not downstream (personal communication Robbin Wagner, USFWS).

The amount of historic Yellowstone cutthroat trout riverine habitat within Montana was estimated at 1,927 miles (Table 9). In addition to riverine environments, 2 lakes were identified as being historically occupied. Little historical information is available for the Montana portion of Yellowstone cutthroat range. Evermann (1891) as part of his investigation of potential hatchery sites visited Reese Creek, a small tributary of the Yellowstone River just north of Yellowstone National Park and Botteler Springs which is located on the westside of the Yellowstone River about 25 miles south of Livingston, Montana. Even though Evermann did not specifically mention trout being present at the sites visited, he did make the comment "the Yellowstone River in the immediate vicinity has an abundance of trout, many individuals of very large size being noticed".

Current occupancy estimates indicate that approximately 625 miles of stream habitat are presently inhabited by Yellowstone cutthroat trout (Table 9). Based on this information, approximately 32% of the historic riverine habitat was felt to be currently occupied by Yellowstone cutthroat trout. Of the three States, Montana's assessment of current occupancy of historic habitat is likely the most accurate. Subsequent to Hadley's (1984) status report, a concerted effort, beginning in 1986, was initiated to more accurately define where "genetically pure" populations occur (Table 6). To date, 98 samples have been sent to the University of Montana for electorphoretic analysis and 65 streams have been identified as having genetically pure populations of Yellowstone cutthroat trout. It is likely that the genetic validation completed to date covers the majority (80 to 90 %) of current riverine populations. Concern for riverine populations led to the formation of an informal working group of fishery professionals who drafted a management guide for future protection and conservation of Yellowstone cutthroat within the Yellowstone River basin (In preparation, Montana Department of Fish, Wildlife and Parks and Wyoming Game and Fish Department). The majority of riverine cutthroat trout populations were determined to be stable but at risk (Table 10). All sub-basins supported exotic species and in eleven (11) sub-basins exotic trout were viewed as a threat to Yellowstone cutthroat trout. Recent expression of the threat exerted by introduced trout has occurred in several instances within the Montana. Competing species such as brown trout (e.g. Bad Canyon Creek, Stillwater drainage) and brook trout (e.g. Smith Creek, Shields River drainage) have replaced cutthroat to a significant degree in many streams. Within Little Mission Creek there has been recent (since 1986) rainbow trout hybridization of the genetically pure cutthroat population probably as a result of rainbow trout movement from a private pond. Yellowstone cutthroat trout (genetically pure) from McBride Lake have been a major part of Montana's mountain lake fishery management and these lake populations will play a valuable role in future conservation. Within Montana, 143 mountain lakes currently support discrete populations which have a high probability of being genetically pure. To date only a few lake populations have been analyzed for genetic status and the results have indicated that a very high percentage are genetically pure Yellowstone cutthroat trout.

Historic references relating to habitat conditions are virtually non-existent. Naturalists who visited Montana made little reference to habitat condition. It is reasonable to assume that historic habitat conditions were favorable for trout and very similar to those observed in Idaho and Wyoming. Current habitat, within Montana, indicates that a substantial number of sub-basins have habitat conditions rated as good to poor (Table 11). A significant number of the sub-basin assessments also indicated that the trend in habitat condition was either stable or declining. It is important to note that information contained in Tables 7 and 8 may at times seem inconsistent. For some sub-basins more than one condition and/or trend was identified and for other sub-basins condition and/or trend may have been omitted. The same is true for the information associated with factors linked to degradation and the land-use activities associated with those factors. Factors affecting aquatic habitat quality and some of the associated land uses are identified in Table 12.

The status of Yellowstone cutthroat trout within National Forests in Montana indicates a substantially higher (64%) occupancy rate (Table 9). No attempt was made to define life history and abundance characteristics but, information gained during the collection of fish for genetic testing indicated that most populations were isolated into resident groups that had little possibility of interaction. Abundance levels were considered as common to rare. All but one of the lakes supporting Yellowstone cutthroat trout were associated with the National Forests in Montana and most were found in wilderness settings. Of the 11 sub-basins which contained Yellowstone cutthroat habitats, 55% were viewed as being in good condition, 36% were rated as fair and 18% were considered poor (Table 11). Condition trend was considered to be stable for most of the sub-basins. For the Custer National Forest 75% of the sub-basins reflected good habitat in a stable trend. Road construction, logging and grazing were the land-uses viewed as having the greatest impact to channel modification, dewatering, limited large woody debris and increases of sediment (Table 12). Within the Gallatin National Forest, good to fair habitat conditions were identified for most sub-basins and the trend was identified as stable. Road construction, logging, and grazing were identified as having the greatest influence on channel modification, limited woody debris and increased sediment. Alteration of hydrograph and/or channel dewatering was also identified as a problem.

POPULATION ECOLOGY AND STATUS SUMMARY

Population ecology of Yellowstone cutthroat trout is likely quite similar to most salmonids native to western portions of the North American continent. Native salmonids in western drainages likely existed as metapopulations (Shaffer 1987; Hanske and Gilpin 1991). There is genetic evidence which supports the probability that Yellowstone cutthroat trout evolved as a distinct metapopulation (Allendorf and Leary 1988). Under metapopulation theory, Yellowstone cutthroat trout probably evolved as groups of sub-populations having varying habitat patch sizes and quality and inter-connectivity. There were likely continuums for occupied habitats, varying from extremely small, low quality headwater habitats to very large, high quality habitat. Connectivity may have been minimal for small, isolated headwater populations and major for the populations associated with the larger adfluvial and fluvial populations which moved annually from one portion of a drainage to another. Movement and subsequent genetic exchange, to varying degrees, by individuals within resident populations were probably limited to portions of the home stream (Rieman et al. 1993), unless high population densities, or catastrophic or climatic events forced individuals to move to downstream locations. Populations occupying larger downstream environments likely served as strategic links to many headwater populations. Not only was there potential for exchange of genetic material; individuals were readily available to re-populate environments when localized extinctions occurred. Under metapopulation theory it is likely that some populations were more stable and robust, while others may have experienced common, localized extinction (Rieman and McIntyre, 1993). Populations within the larger tributary streams and the mainstem rivers at times would have acted as "sources" and at other times "sinks" (Pulliam, 1988; Stacey and Taper, 1992).

Environmental considerations are of importance in metapopulation theory. Quality and quantity of living space (e.g environmental patch size) are important factors which determine the presistence on individual populations. Local headwater environments and those environments into which the headwater streams flowed, theoretically, would be influenced by random environmental events more than would larger, diverse environments. Populations associated with complex habitats tend to be more stable than those in simple habitats because they have greater refuge from environmental change (Reimen and McIntyre, 1993 and others). From an evolutionary perspective, connectivity between Yellowstone cutthroat populations and availability of a diverse array of localized populations residing in high quality habitat served to provide long-term stability and lowered the potential risk of total extinction.

Unfortunately, many Yellowstone cutthroat trout populations, currently exist as localized remnants (Table 13) of original sub-populations with little or no connectivity. Others owe their existence to hatchery programs. Current estimates indicate that Yellowstone cutthroat occupy 41% of historic riverine environments throughout the historic range. In addition, there are about 450 lake environments, within the historic range, that currently support Yellowstone cutthroat trout. The number of lake environments currently supporting Yellowstone cutthroat populations represents a 380% increase over historic levels. Additionally, there are now numerous riverine and lake populations in existence outside of the historic range (Hadley 1984; Varley and Gresswell 1988) resulting from extensive stocking.

Caution should be applied before developing conclusions relative to overall Yellowstone cutthroat status. With the exception of populations in Montana, most populations have not received sufficient testing for a definitive assessment of genetic status (Table 14). Based on the findings in Montana, genetic contamination is probable for most cutthroat populations that have been exposed to rainbow trout or cutthroat of hatchery origin. As pointed out in this assessment and others previously cited, fragmentation and population isolation has occurred as a result of stream dewatering, replacement by introduced non-native fish, hybridization, substantial environmental change, and overharvest. Many populations find themselves in a form of ecological "catch 22". Most owe their current existence to passage barriers, whether natural or man-made, which have effectively controlled access of both contaminating and competitive species which are present in nearly all areas of the current range (Table 15). At the same time these populations find themselves restricted to relatively small "patches" of habitat that have, in many cases, been degraded by human activity. Viability concerns increase with decreasing "patch" size, declining habitat quality, and complexity, and increased isolation from "source" populations.

Aquatic environments inhabited with Yellowstone cutthroat trout on National Forest lands tend to be in better condition and support more populations. Present estimates indicate that 63% of historic riverine habitats on National Forests still support populations of Yellowstone cutthroat. Most of the currently occupied lake habitats are found on National Forest administered lands. Because of limited genetic testing, caution should be used before development of final conclusions relative to current status within the National Forests. As more definitive genetic information becomes available, it is likely that fewer genetically pure populations will actually exist on the National Forests.

MANAGEMENT CONSIDERATIONS

The long-term well-being of Yellowstone cutthroat trout will require a comprehensive and well coordinated conservation approach. A shared vision of goals and objectives between agencies and individuals that have legal responsibilities and vested interests will be essential to long term success. An on-going effort to develop a management guide for Yellowstone cutthroat trout within the Yellowstone River basin should be a management catalyst for developing the shared vision of responsible agencies and individuals. The "Management Guide" recommends goals for providing protection, maintenance and restoration within the historic range of Yellowstone cutthroat trout. The Management Guide is equally applicable to the Snake River portion of the historic range. Principle components associated with the management guide and specific application based on findings of this assessment include the following:

Protection

First priority of any conservation strategy should be focused on protection of remaining populations. It is essential that genetic and population integrity be preserved and protected. This includes not only protection of individual fish and associated populations, it includes protection of aquatic environments and related watersheds. Protection implies that there is sufficient information available to identify where genetically pure populations exist and an understanding of population health and environmental (ecological) condition. Protection implies elimination of detrimental influences.

1. Yellowstone cutthroat trout populations need to be screened for genetic purity. This is especially true for populations in Idaho and Wyoming where only limited testing has occurred to date. Information collected during genetic validation of Montana cutthroat populations revealed that a substantial number of populations have been contaminated by rainbow trout and other cutthroat subspecies. Information on genetic status will provide a clearer understanding of the need for protection.

2. Yellowstone cutthroat trout populations in all three states will benefit from protection from non-native fish, primarily introduced salmonids. Hybridization and replacement have drastically influenced Yellowstone cutthroat trout throughout the historic range. Introductions of rainbow and hatchery cultured cutthroat trout have contributed to massive hybridization. Introductions of brown trout, brook trout and other fish species have depressed cutthroat populations and have in some instances led to total biotic replacement. Protection of remaining populations of genetically pure Yellowstone cutthroat trout will require States to insure that stocking of non-native salmonids does not occur and that non-native fish access into Yellowstone cutthroat trout habitat is restricted.

3. Protection of Yellowstone cutthroat habitat is essential for preservation of current populations. A significant number of populations exist within headwater areas in small stream settings. Habitat condition, to a substantial degree, serves as the controlling influence of individual health and population stability. Land-uses which can have negative influences on habitat need to be modified to minimize affects. This is particularly true for habitat on the National Forests and other federal lands. Future preservation of Yellowstone cutthroat trout will likely be dependent upon healthy aquatic ecosystems occurring within Yellowstone National Park, the eight National Forests and to a lesser degree BLM lands.

4. Implementation of harvest regulations is necessary for population protection. States should review current harvest regulations and implement those changes that would serve to protect Yellowstone cutthroat from over harvest. The National Forests, National Park Service and other land management agencies need to evaluate access and user facilities and implement changes needed to provide protection.

Maintenance and Enhancement

It is important to take the necessary actions to improve upon conditions that are considered to be less than ideal so as to insure long-term maintenance of the pure populations. Maintenance and enhancement therefore become the second priority of Yellowstone cutthroat trout conservation. Enhancement of ecological condition, both biotic and abiotic, serves as a primary action. Maintenance would include those actions necessary to improve the potential for long-term existence of each pure population.

1. Maintenance and enhancement may require removal of hybridizing and competitive species from within Yellowstone cutthroat trout watersheds or adjacent drainages. In situations where Yellowstone cutthroat populations are likely to be negatively influenced by other fish species, the States will need to take appropriate action to eliminate potential threats.

2. Some populations may require artificial supplementation to off-set negative influences associated with limited exchange of genetic material or to provide critical mass necessary for population increases.

3. A significant number of the sub-basins had habitats that were rated less than good. Habitat restoration and enhancement actions that would lead to increasing habitat quality ratings should be implemented, especially for habitats within the National Forests and other federal lands.

4. It may also be beneficial to extend current distribution by introducing Yellowstone cutthroat into waters which were not historically occupied but are within the historic range. Included would be lakes and streams that were historically fishless but that currently support non-native species. It may also be desirable to introduce Yellowstone cutthroat into environments that are currently fishless pending a thorough analysis of each water proposed.

5. Maintenance of Yellowstone cutthroat trout populations existing outside of the historic range may serve to enhance the conservation of this subspecies. If populations existing outside of the historic range pose little threat to native flora and fauna, preservation of these populations should be considered as a conservation measure. This would only apply to genetically pure populations and protective and maintenance considerations would apply.

Restoration of Yellowstone Cutthroat Trout

The third focus (priority) of Yellowstone cutthroat conservation would be associated with increasing the number of pure populations and expanding the distribution within the historic range. Protection and maintenance of existing populations will likely be insufficient to insure long-term Yellowstone cutthroat existence in some of the smaller streams. There is a very real need to increase population numbers and distribution as an effective hedge against localized extinctions. To the extent biologically feasible and socially acceptable, Yellowstone cutthroat trout should be re-established into historic habitats. Decisions associated with restoration should also include provisions for future protection and maintenance.

1. Consideration should be focused on genetic restoration of hybridized populations through repeated introductions of genetically pure individuals. Population specific genetic information will be needed to evaluate the applicability of this option.

2. States should consider replacement of non-native fish species and re-establishment of genetically pure Yellowstone cutthroat populations in as many streams and lakes as practical.

FINAL CONCLUSIONS

In addition to protection, maintenance and restoration efforts, there is a need for increased research and education. The current status of Yellowstone cutthroat trout is a result, in large measure, of a poor

understanding of man's actions and influence. The decline in Yellowstone cutthroat can be attributed to non-native species introductions, habitat changes and overharvest.

The success of any conservation strategy, focused on insuring long-term well-being of Yellowstone cutthroat trout, will be proportional to public acceptance and an improved understanding of ecological consequences. Successful conservation will be dependent upon a willingness, of those that have a responsibility to Yellowstone cutthroat trout, to actually do something to make conditions better. To date, the saying "*When all is said and done, more is said than done*" dramatically applies to the conservation of native fishes and specifically to fish within the western United States, including Yellowstone cutthroat trout. It is yet to be seen, in the conservation of Yellowstone cutthroat trout, if the saying can and will be re-written to reflect that "When all was said and done, more was done and than ever said".

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TABLE 1. Distribution and demographic information for Yellowstone Cutthroat Trout within the Snake River basin downstream from Idaho-Wyoming state line.

Sub-basin	Associated National Forest	Land status by sub-basin (%)					Historic Habitat		Occupied Habitat		Percent Occupied		National Forest Historic Habitat		National Forest Occupied Habitat		National Forest Percent Occupied
		FS	BLM	NPS	PVT	Other	Stream (Miles)	Lake (#)	Stream (Miles)	Lake (#)	Stream	Lake	Stream (Miles)	Lake (#)	Stream (Miles)	Lake (#)	Stream Lake
Snake River (Shoshone Falls to American Falls)	Sawtooth	5	30		60	5	373	0	0	0	0	-	25	0	0	0	0-
Goose Creek (1)	Sawtooth	25	30		40	5	265	0	29	0	11	-	86	0	0	0	0-
Raft Creek (1)	Sawtooth	25	40		33	2	375	0	12	1	3	100	53	0	0	0	0-
Snake River (American Falls to Henry's Fork)	Caribou	2	15		64	19	245	0	245	1	100	100	7	0	7	0	100-
Bannock Creek	Caribou	0	20		29	51	116	0	0	1	0	100	-	-	-	-	--
Portneuf River	Caribou	15	10		65	10	323	0	0	1	0	100	36	0	0	1	0100
Blackfoot River	Caribou	10	2		63	25	393	0	0	1	0	100	57	0	0	1	0100
Willow Creek	Caribou	5	3		74	18	286	0	286	1	100	100	16	0	16	0	100-
Henry's Fork Snake River (Confluence to St. Anthony)	Targhee	0	30		65	5	44	0	44	0	100	-	-	-	-	-	--
Teton River	Targhee	33	3		55	9	443	0	443	0	100	-	64	0	64	0	100-
Henry's Fork Snake River (St. Anthony to Henry's Lake)	Targhee	50	8	21	15	8	279	0	27	2	10	200	127	0	0	0	0-
Falls River	Targhee	35	1		64		100	0	0	0	0	-	27	0	0	0	0-
Warm River	Targhee	80	2	13	3	2	97	0	97	0	100	-	77	0	77	0	100-
Buffalo River	Targhee	89	1		5	5	19	0	0	0	0	-	19	0	0	0	0-
Henry's Fork (above Henry's Lake)	Targhee	63	2		25	10	58	1	58	1	100	100	35	0	35	0	100-
South Fork Snake River (Henry's Fork to Palisades Res)	Targhee	50	5		40	5	171	0	171	0	100	-	98	0	98	0	100-
South Fork Snake River (above Palisades Res) (2)	Caribou	59	1		34	6	100	2	100	1	100	50	96	0	96	1	100100
Jackknife Creek (2)	Caribou	90			10		17	0	17	0	100	-	13	0	13	0	100-
Tincup Creek (2)	Caribou	90			10		36	0	36	0	100	-	31	0	31	0	100-
Stump Creek (2)	Caribou	50	5		42	3	17	0	17	0	100	-	11	0	11	0	100-
Crow Creek (2)	Caribou	75	3		20	2	40	0	40	0	100	-	33	0	33	0	100-

(1) Include information from Nevada and Utah
(2) Supports both large and fine spotted forms

Table 2. Idaho Yellowstone Cutthroat Trout population status - Based on information from 21 sub-basins.

Status Secure - expanding	Number of Sub-basins	Percentage
Secure - stable	2	10
At Risk - stable	6	29
At Risk - declining	3	14
Unknown	9	43
Exotic species present	19	90
Exotic species viewed a threat	16	76

Table 3 Habitat condition status for sub-basins supporting Yellowstone Cutthroat Trout within Idaho. Condition and trend entries are percentages.
Exc = excellent, ExD = extremely degraded, Inc = increases, Stab - stable, Dec - decreasing, Unk = unknown

	Sub-basins	Overall Condition					Trend			
		Exc	Good	Fair	Poor	ExD	Inc	Stab	Dec	Unk
Other Lands	20		24	33	43	14	5	29	5	52
National Forests	19		47	37	16			42		47
Caribou*	10		20	40	20			20		60
Sawtooth*	3			33	33					67
Targhee	7		86	43				86		14

*One sub-basin is shared by both Caribou and Sawtooth National Forests

Table 4 Factors affecting habitat quality of Yellowstone Cutthroat Trout in Idaho. Factor and land-use activity entries are percentages.
DW = dewater, Chem = chemical pollution, Temp = temperatures, CM = channel modification, LW = limited wood, Sed = sediment

	Sub-basins	Factors Affecting Habitat Condition						Land-use Activities Associated with Factors				
		DW	Chem	Temp	CM	LW	Sed	Grazing	Mining	Logging	Road Const	Agriculture
Other Lands	20	75	10	70	80	75	95	90	10	25	25	85
National Forests	19	21		32	53	37	63	79	16	32	26	
Caribou*	10	10		60	80	50	70	80	30	40	50	
Sawtooth*	3	33			67	67	33	67				
Targhee	7	29			29		57	71		29		

*One sub-basin is shared by both Caribou and Sawtooth National Forests.

TABLE 5 Distribution and demographic information for Yellowstone Cutthroat Trout in the Wyoming portions of the Snake and Yellowstone Rivers

Sub-basin	Associated National Forest	Land status by sub-basin (%)					Historic Habitat		Occupied Habitat		Percent Occupied		National Forest Historic Habitat		National Forest Occupied Habitat		National Forest Percent Occupied
		FS	BLM	NPS	PVT	Other	Stream (Miles)	Lake (#)	Stream (Miles)	Lake (#)	Stream	Lake	Stream (Miles)	Lake (#)	Stream (Miles)	Lake (#)	Stream Lake
Snake River (Palisades Res to Jackson Lake) (1)	Bridger-Teton	39	4	22	29	2	304	50	323	63	106	126	111	7	118	12	106171
Salt River (1)	Bridger-Teton	40	1		49	11	170	[illegible]	215	35	126	3500	63	1	63	6	100600
Greys River (1)	Bridger-Teton	100					50	[illegible]	200	7	100	350	184	2	184	7	100350
Hoback River (1)	Bridger-Teton	89			10	1	187	0	26[illegible]	14	141	1400	150	0	200	4	133400
Gros Ventre River (1)	Bridger-Teton	90		1	6	3	283	1[illegible]	283	33	100	194	220	17	220	28	100165
Spread Creek (1)	Bridger-Teton	92		8			47	1	47	2	100	200	41	1	41	2	100200
Lower Buffalo Creek (1)	Bridger-Teton	71		18	11		50	1	50	3	100	300	29	1	29	2	100200
Upper Buffalo Creek (1)	Bridger-Teton	100					5[illegible]	1	94	15	100	750	90	2	90	15	100750
Pacific Creek (1)	Bridger-Teton	90		10			47	6	47	14	100	233	63	8	63	14	100233
Snake River (Jackson Lake to headwaters)	Bridger-Teton	42		58			169	4	169	13	100	325	68	1	68	10	10001000
Yellowstone River (Headwaters above Park)	Bridger-Teton	100					155	0	155	0	100	-	155	0	155	0	100-
Yellowstone River (Falls upstream to Park boundary)				100			695	12	695	12	100	100	-	-	-	-	--
Yellowstone River Falls (Downstream to Park boundary)				100			427	0	427	0	100	-	-	-	-	-	--
Clarks Fork Yellowstone River (Stateline to headwaters)(3-4)	Shoshone/ Gallatin	85	10		5		931	0	481	12	196	1200	526	0	368	12	1431200
Bighorn River (Stateline to Themopolis)(3)	Bighorn	20	70		5	5	33	0	14	0	24	-	11	0	11	0	100-
Shoshone River(3)	Shoshone	40	10		50		155	0	525	35	30	3500	689	0	345	28	502800
Shell Creek	Bighorn	20	10		70		187	6	24	8	17	133	59	6	10	8	17133
Bighorn tributaries (East side)	Bighorn	-	-	-	-	-	39	0	26	0	23	-	2	0	2	0	100-
Greybull River(3)	Shoshone	20	50		25	5	1596	0	39	4	25	400	259	0	155	0	60-
Nowood River	Bighorn	10	50		35	5	287	0	33	4	8	400	40	0	22	4	55400
Painted Rock Creek	Bighorn	-	-	-	-	-	108	0	33	3	31	300	45	0	13	3	29300
Wind River(3)	Shoshone	20	10		25	45	2612	0	26	0	1	-	1040	0	10	0	1-
Little Bighorn River (Stateline to headwaters)	Bighorn	80	1		11	8	39	1	47	0	39	0	77	0	20	0	26-
Tongue River (Stateline to headwaters) (2)	Bighorn	25	1		71	3	331	0	33	0	10	-	89	0	26	0	29-
Goose Creek (2)	Bighorn	40	1		57	2	283	10	47	20	13	200	39	10	18	20	46200

(1) Both the fine and large spotting patterns are present with headwater streams most likely to have large spotted cutthroat and the larger streams having fine spotted cutthroat. (Personal communication, Mark Novak)
(2) Both spotting patterns present as a result of hatchery stocking.
(3) Stream mileages for both historic and currently occupied habitat are likely over estimates and include stream sections which would not support fish.
(4) It is likely that most of the Clark Fork of the Yellowstone within Wyoming was historically fishless.

Table 6 Wyoming Yellowstone Cutthroat Trout population status. Based on information from 25 sub-basins.

Status Secure - expanding	Number of Sub-basins	Percentage
Secure - stable	18	72
At Risk - stable	7	28
At Risk - declining		
Unknown	1	4
Exotic species present	24	96
Exotic species viewed a threat	12	48

Table 7 Habitat condition status for sub-basins supporting Yellowstone Cutthroat Trout within Wyoming. Condition and trend entries are percentages.
Exc = excellent, ExD = extremely degraded, Inc = increases, Stab - stable, Dec - decreasing, Unk = unknown

	Sub-basins	Overall Condition					Trend			
		Exc	Good	Fair	Poor	ExD	Inc	Stab	Dec	Unk
Other Lands	21	5	19	43	19			67	10	19
National Forests	23	4	74	26			4	87	4	4
Bridger Teton	11	9	100					100		
Shoshone	4		50	50			25	75	25	
Big Horn	8		50	50				75		25

Table 8 Factors affecting habitat quality of Yellowstone Cutthroat Trout in Wyoming. Factor and land-use activity entries are percentages.
DW = dewater, Chem = chemical pollution, Temp = temperatures, CM = channel modification, LW = limited wood, Sed = sediment

	Sub-basins	Factors Affecting Habitat Condition						Land-use Activities Associated with Factors				
		DW	Chem	Temp	CM	LW	Sed	Grazing	Mining	Logging	Road Const	Agriculture
Other Lands	18	56	28	6	81	61	87	72	33	17	44	33
National Forests	23	43	17		57	57	70	61	26	39	35	
Bridger Teton	11	55	9		73	82	82	45		18	18	
Shoshone	4	100	75		100	100	100	75	75	100	25	
Big Horn*	8				13		38	75	38	38	50	

*50% of sub-basins did not report on factors affecting habitat condition.

TABLE 9. Distribution and demographic information for Yellowstone Cutthroat Trout within Montana.

Sub-basin	Associated National Forest	Land status by sub-basin (%)					Historic Habitat		Occupied Habitat		Percent Occupied		National Forest Historic Habitat		National Forest Occupied Habitat		National Forest Percent Occupied
		FS	BLM	NPS	PVT	Other	Stream (Miles)	Lake (#)	Stream (Miles)	Lake (#)	Stream	Lake	Stream (Miles)	Lake (#)	Stream (Miles)	Lake (#)	Stream Lake
Yellowstone River (Park boundary to Shields River)	Gallatin	45	1		53	1	239	0	120	3	50	300	133	0	69	3	52300
Slough-Soda Butte	Gallatin	50		45	5		108	1	75	2	71	200	31	0	12	1	39100
Mill Creek	Gallatin	75	1		24		53	0	48	1	90	100	39	0	39	1	100100
Tom Miner Creek	Gallatin	40	1		57	2	32	0	32	0	100	-	11	0	11	0	100-
Shields River	Gallatin	30	1		67		272	0	49	3	18	300	75	0	49	3	65300
Yellowstone River (Shields River to Clarks Fork)	Gallatin	10	2		84	4	421	0	115	5	27	500	58	0	38	5	64500
Boulder River	Gallatin	85			14	1	87	0	60	20	69	2000	60	0	25	20	422000
Stillwater River	Custer	65	1		33	1	208	0	55	40	26	4000	100	0	55	40	554000
Rock Creek	Custer	45	1		53	1	151	1	41	25	27	2500	75	1	30	25	402500
Clarks Fork Yellowstone River (To stateline)	Custer	8	25		65	2	88	0	14	44	18	4400	20	0	14	44	704400
Yellowstone River (Clarks Fork to Bighorn)			5		75	20	110	0	0	0	0	-	-	-	-	-	--
Bighorn River Tributaries	Custer	1	1	5	43	50	75	0	11	0	15	-	57	0	11	0	19-
Little Bighorn River					50	50	85	0	5	0	8	-	-	-	-	-	--

Table 10 Montana Yellowstone Cutthroat Trout population status - Based on information from 13 sub-basins.

Status Secure - expanding	Number of Sub-basins	Percentage
Secure - stable	1	8
At Risk - stable	9	69
At Risk - declining		
Unknown	2	15
Exotic species present	13	100
Exotic species viewed a threat	11	85

Table 11 Habitat condition status for sub-basins supporting Yellowstone Cutthroat Trout within Montana. Condition and trend entries are percentages.
Exc = excellent, ExD = extremely degraded, Inc = increases, Stab - stable, Dec - decreasing, Unk = unknown

	Sub-basins	Overall Condition					Trend			
		Exc	Good	Fair	Poor	ExD	Inc	Stab	Dec	Unk
Other Lands	13		8	75	33			50	50	8
National Forests	11		55	38	18			82	9	9
Custer	4		75	25				100		
Gallatin	7		43	43	29			71	14	14

Table 12 Factors affecting habitat quality of Yellowstone Cutthroat Trout in Montana. Factor and land-use activity entries are percentages.
DW = dewater, Chem = chemical pollution, Temp = temperatures, CM = channel modification, LW = limited wood, Sed = sediment

	Sub-basins	Factors Affecting Habitat Condition						Land-use Activities Associated with Factors				
		DW	Chem	Temp	CM	LW	Sed	Grazing	Mining	Logging	Road Const	Agriculture
Other Lands	13	92	46	75	85	54	100	85	31	38	85	46
National Forests	11	64	9	9	55	55	64	64	9	45	73	
Custer	4	50			25	25	25	75		25	75	
Gallatin	7	71	14	14	71	71	86	57	14	57	71	

Table 13 Origin, life history and well being of current Yellowstone Cutthroat Trout in Idaho, Wyoming, and Montana. Tabular entries are percentages.
REM= reminent, Trans = transplanted, UNK = unknown, RES = resident, FLV = fluvial, ADF = adfluvial, ABD = abundent, Comm = common, EXT = extinct

State	# Analysis Areas	Origin of Populations				Life History				Abundance			
		REM	Hatchery	Trans	UNK	RES	FLV	ADF	UNK	ABD	Comm	Rare	EXT
Idaho	21	100	62	10	5	71	81	14	10	24	38	38	5
Wyoming	25	96	92	4		96	48	20	4	52	28	32	
Montana	13	77	62	15	8	69	38		8	8	54	31	15

Table 14 Genetic Validation Information available from the sub-basins for Idaho, Wyoming and Montana. Entries are percentages.

State	# Analysis Areas	Meristics	Electrophoresis	DNA	Visual
Idaho	21	14	5		29
Wyoming	25	28	24		44
Montana	13	46	69	8	

Table 15 Presence of exotic fish species, including cutthroat from another geographic location (e.g., fine spot to large spot). Entries are percentages.

State	# Analysis Areas	Rainbow	Brook	Brown	Cutthroat	Other
Idaho	21	76	57	62	5	5
Wyoming	25	72	84	60	44	48
Montana	13	100	77	85		

Chapter 3

Bonneville Cutthroat Trout
Oncorhynchus clarki utah

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INTRODUCTION

The Bonneville cutthroat trout (BCT) is the only trout native to the Great Basin within Utah. This subspecies is endemic to the Bonneville Basin, the largest endorheic basin in the Great Basin of the western North America, comprising about 132,650 km^2. Lake Bonneville once extended over 51,840 km^2, with a maximum depth of over 300m. About 30,000 years ago the Bear River lost its connection with the Snake River through volcanic activity and changed its course into the Bonneville Basin. Ancestral cutthroat trout could have been present before this divergence but would have been exposed to Yellowstone cutthroat trout from the upper Snake River basin as the Bear River flowed into the Bonneville Basin. Historically, subspecies are geographical races, isolated and differentiated from all other subspecies of the species. Probably two separate ancestral invasions of the Bonneville basin occurred. Both invasions would have probably come from similar ancestor Yellowstone cutthroat trout of the Snake River and some mixing-blending should have occurred (Dr. Robert Behnke, personal communication 1996). Behnke states that although the Bear River *utah* do share more close-relatedness to the Yellowstone cutthroat, because they came into the basin later than the first invasion, they share enough similarities to the other *utah* for all to be regarded as one subspecies. This mixing and the apparent genetic differentiation is evident today between the Bonneville cutthroat trout from the Bear River basin and those from the main Bonneville Basin (Behnke 1992, Hickman 1978, Shiozawa et al. 1993).

The subspecies was historically abundant throughout all suitable waters of the vast Bonneville basin area encompassing portions of Utah, Nevada, Idaho, and Wyoming until about 8,000 years ago during the final desiccation of ancient Pleistocene Lake Bonneville (Broecker and Kaufman 1965, Hunt 1953). At this time the cutthroat trout were forced into streams throughout the basin, forming isolated, disjunct populations (Figure 1). For example, the Snake Valley strain of the Bonneville cutthroat has been geographically isolated from the eastern Bonneville Basin for about 8,000 years. However, reproductive isolation may have occurred long before that time as glacial Lake Bonneville was noted for many large lake level fluctuations during its history. Many populations throughout the basin became isolated from one another since that time by this natural habitat fragmentation. The lake`s Snake Valley arm was rather ephemeral in geographical time, and only during the lakes maximum elevation (ca. 18,000 BP) was it connected, and then isolated from the rest of the basin as the lake level dropped (Behnke 1976). Zoogeographical evidence for fish distribution in the Great Basin points to their occurrence habitats in which they have been able to reach through surface-water migrations. Thus, their dispersal is very closely linked with climate and hydrogeographic history (Hubbs and Miller 1948).

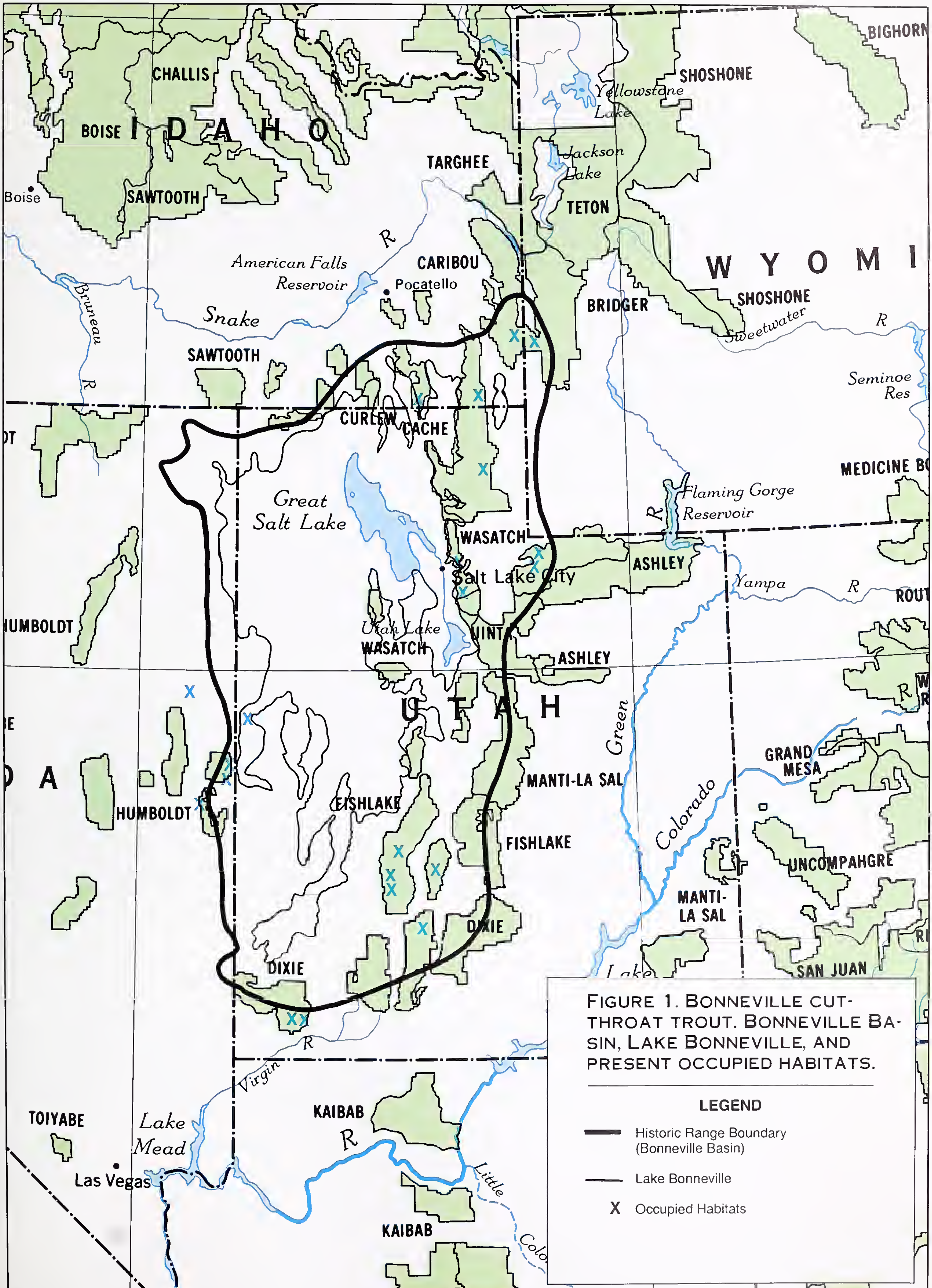

FIGURE 1. BONNEVILLE CUTTHROAT TROUT. BONNEVILLE BASIN, LAKE BONNEVILLE, AND PRESENT OCCUPIED HABITATS.

So, it appears that the Snake Valley population, as well as other sub-basin specific populations, could have evolved through events possibly during relatively short periods of desiccation, when trout were isolated in Snake Valley, and in other areas of the basin. As lake levels rose again, the trout may have maintained reproductive isolation in their parent stream. Such reproductive isolation would have allowed sufficient time for considerable genetic divergence. The presence of this unique race should be concern for protection of remaining relic populations throughout the basin. It is recognized that BCT are a diverse group within the cutthroat trout subspecies. Scientists recommend the various existing populations should be considered unique entities and mixing of the groups should be avoided (Behnke and Zarn 1976, Shiozawa, Evans and Williams 1993).

While some stream populations survive, the BCT evolved primarily in a lake (lacustrine) environment. Upon desiccation of Lake Bonneville, trout were primarily restricted to perennial tributaries, and connected watersheds and sub-basins; only Bear Lake, Utah Lake, and Panguitch Lake retained lacustrine populations. These historic lake populations have been extirpated except in Bear Lake. Remaining BCT populations in the Bonneville Basin are a unique evolutionary and biological heritage of the Great Basin. However, during the last 150 years the Bonneville cutthroat trout metapopulations have been significantly reduced through anthropogenic activities. This loss of connectivity to sub-basins, non-native introductions, habitat fragmentation, and decreases in BCT throughout the Basin continue to threaten its recovery and may even preclude its future survival.

In the most recent comprehensive review of the taxonomy and distribution of cutthroat trout, Behnke (1992) separates BCT into three slightly differentiated groups associated with: (1) the Bonneville Basin proper (including the Ogden, Provo, Weber, and Sevier River drainages); (2) the Snake Valley of Utah; and (3) the Bear River drainage. Research by Shiozawa et al. (1993) also categorized the Bonneville cutthroat trout into three main subgroups: (1) the Bear River form; (2) the Southern Bonneville form (actually described from the Virgin River drainage); and (3) the main Bonneville Basin form.

However, for the purposes of this habitat conservation assessment (HCA), I will differentiate the cutthroat trout groups within the Bonneville Basin into four hydro-geographic areas: (1) Bear River Bonneville cutthroat trout (BRB), including those population within the Bear River basin of Utah, Idaho, and Wyoming, from its headwaters to entry into the Great Salt Lake; (2) Northern Bonneville cutthroat trout (NB), which includes the waters of the Ogden, Weber, Jordan, and Spanish Fork Rivers, and the Utah Lake sub-basins; (3) Southern Bonneville cutthroat trout (SB), which includes the Sevier River, Sevier Lake, and Escalante Desert sub-basins, as well as the Upper Virgin River sub-basin in the Colorado River Basin, where several transplanted populations exist; and (4) Western Bonneville cutthroat trout (WB), which includes the Utah-Nevada portion of the Great Salt Lake Desert, from the Raft River Range on the north to the Snake Valley area on the south, also including a "closed sub-basin" in adjacent Nevada, where several transplanted populations occur (Figures 2 and 3).

ASSESSMENT METHODS

The assessment conducted for BCT populations was outlined in the HCA Introduction section. State and federal fisheries managers within the Bonneville Basin (Utah, Nevada, Wyoming, and Idaho) were contacted and provided the HCA questionnaire for completion. In addition, others with experience and expertise in BCT occurrence and distribution were contacted, including individuals from universities, other state and federal agencies, and conservation groups.

Historical references relating to the occurrence, distribution, and abundance were used to provide a historical perspective to existing status and distribution. While primarily qualitative, the historical observations provided information on trout habitat occurrence and good stream and riparian habitat condition. I assumed that 25% of the intermittent stream miles were historically once perennial waters which have been altered by anthropogenic activities (UDWR 1991). Similarly, I assumed that up to 90% of most perennial waters historically contained BCT populations. Historical records cited provide reference to trout occurrence in most perennial waters containing suitable habitat, from headwaters to low-elevation reaches. Many waters once tributary to Lake Bonneville still provide perennial stream habitat, with seasonal use of some intermittent reaches, as stream channels dip and meander below higher terraces of the ancient lake (Hubbs and Miller 1948).

Information for mapping and stream mileage by sub-basin, both perennial and intermittent, was obtained from the U.S. Geological Survey and Utah Automated Geographic Reference Center geographic information system (GIS) data. Maps of the Bonneville basin and individual national forest maps were also used to validate stream miles and population location. State and federal resource data bases, where available, were also used.

CURRENT STATUS

The BCT in the Bonneville Basin is considered a unique subspecies of western cutthroat trout. Previous status reports have identified the need to protect its remaining populations and habitats by state and federal management agencies throughout its range. The American Fisheries Society (AFS), in 1979, listed BCT as "threatened" throughout its range due to continuing degradation of habitat and hybridization with exotic (non-native) species. The U.S. Fish and Wildlife Service (FWS), in 1980, the FWS announced a status review of the BCT. In 1982, the FWS identified the BCT as a Category II candidate species (47 FR 58454, December 30, 1982). The FWS, in 1985, re-classified the BCT as a Category I candidate species (50 FR 37958, September 18, 1985). The AFS, in 1989, re-classified BCT as "endangered". The FWS, in 1994, listed the BCT as a declining candidate species, Category II (59FR 58982, November 15, 1994). In 1996, under revised priorities for listings, the FWS has discontinued their Categorical status, and only those species previously identified as Category I are now considered candidate species. The BCT therefore, is not a candidate species at this time, but the FWS remains concerned about BCT status and encourages further research and study to resolve its conservation status. Utah considers the BCT a species of special concern (S1 status) and has considered it within a conceptual management plan for all cutthroat trout in Utah (Schmidt et al. 1995). Also, in 1995, Utah formed a interagency conservation team for the BCT and has developed a draft conservation agreement and strategy plan for its recovery (UDWR 1996). In addition, similar ongoing conservation strategy efforts are being undertaken in Nevada, Idaho, and Wyoming for BCT. Figure 1 illustrates the historic range of the Bonneville cutthroat trout.

This assessment reports current status and recent investigations, primarily on national forest system (NFS) lands by state and federal biologists. This assessment identifies 67 pure populations occupying habitats on NFS lands, including four lakes, in 15 major sub-basins, two are located outside the Bonneville Basin (Figures 2 and 3). The following occurrence of these populations on NFS lands, by state, is: Utah 48%, Wyoming 33%, Idaho 13%, and Nevada 6%. In addition, there are 15 populations occupying an estimated thirty-four stream miles which may be classified as "suspect" pure BCT, but additional genetic validation is necessary to clarify the uncertainty in lineage. This concern for determination of genetic status is most prevalent in the Bear River sub-basins where the native cutthroat trout (BRB) shares a close-relatedness to the Yellowstone cutthroat trout from ancestral invasions into the Bonneville basin and Lake Bonneville (Behnke 1992; Shiozawa and Evans 1994, Behnke and Probstel 1995).

Overall, the assessment indicates that a total of 81 pure populations exist within the basin. The additional populations off NFS lands occur on other federal, state, and private lands. The total includes those which have been established from remnant populations. Populations occupying NFS lands account for 83% of BCT populations. The BLM lands account for 14%, while state, county, and private lands each support 1% of BCT populations. Although the BCT's current distribution has been greatly reduced from its historical range, and existing populations throughout the Basin continue to remain at risk in overall status, the replicated populations tend to be secure, stable, and expanding within their occupied habitat.

Other states within the Bonneville Basin, with shared responsibility for BCT management also consider special status for the subspecies. In 1987, Nevada developed an interagency "Bonneville cutthroat trout species management plan", in cooperation with the FS and BLM for management and restoration activities in the Snake Valley-Spring Valley sub-basins (Haskins, 1987). Nevada formerly classified the BCT a "state sensitive" species, but in 1995 that designation was dropped, and the BCT classified only as a game fish with no special harvest restrictions. The BCT is considered a sensitive species and a species of special concern by: Wyoming, the Forest Service (FS), and by each of the four Bureau of Land Management (BLM) State Offices. Wyoming developed an interagency 5-year management plan (1993-1997) to govern management and conservation strategies between the state, FS, and BLM in southwestern Wyoming sub-basins (Remmick et al. 1993, Binns 1981).

Idaho considers the BCT to be a sensitive species. In 1994, Idaho developed an inter-agency "Habitat Conservation Assessment and Strategy for the Bonneville Cutthroat Trout", in cooperation with the FS and BLM. They also developed a separate, single drainage, Conservation Agreement (CA) for the Thomas Fork of the Bear River, in cooperation with the FS, FWS, and the local grazing association. The intent of these documents was to facilitate management designed to reverse the decline of BCT habitat and populations in southeastern Idaho (Skully 1993, 1995).

RESULTS AND DISCUSSION

This assessment of status and distribution is intended to both expand and reinforce earlier reports documenting the occurrence and abundance of the BCT (Hickman 1977, Duff 1977, Hickman and Duff 1978, Duff 1988, Behnke 1992, Kershner 1995). Current information is based on the results of questionnaires, interviews, ongoing field investigations, and professional knowledge of the subspecies over its entire range. In order to ease reporting and discussion, the findings will be presented by BCT population, group, location, and hydrologic sub-basins, by state, and by National Forest (Figures 2 & 3).

BONNEVILLE BASIN

The occurrence of the BCT within the Bonneville Basin since the desiccation of ancient Lake Bonneville left the subspecies isolated in four separate, major geographic areas, namely the WB were geographically isolated in desert "island ecosystem" mountain ranges, while the three other populations, i.e. BRB, NB, and SB occupied rather large riverine systems in major basins that contained high quality habitat and strong populations capable of dispersing within sub-basins supporting metapopulations. However, some populations, like the WB and SB forms, became isolated with no connectivity to larger waters due to occurrence in mountain streams separated by desert valleys. This assessment estimates that 90% of Bonneville Basin sub-basins historically contained the BCT (Tables 1,2). Since the Bonneville Basin occupies a four state area, several sub-basins are shared between the States of Utah, Nevada, Idaho, and Wyoming. The BCT occurrence in sub-basins will consider each State

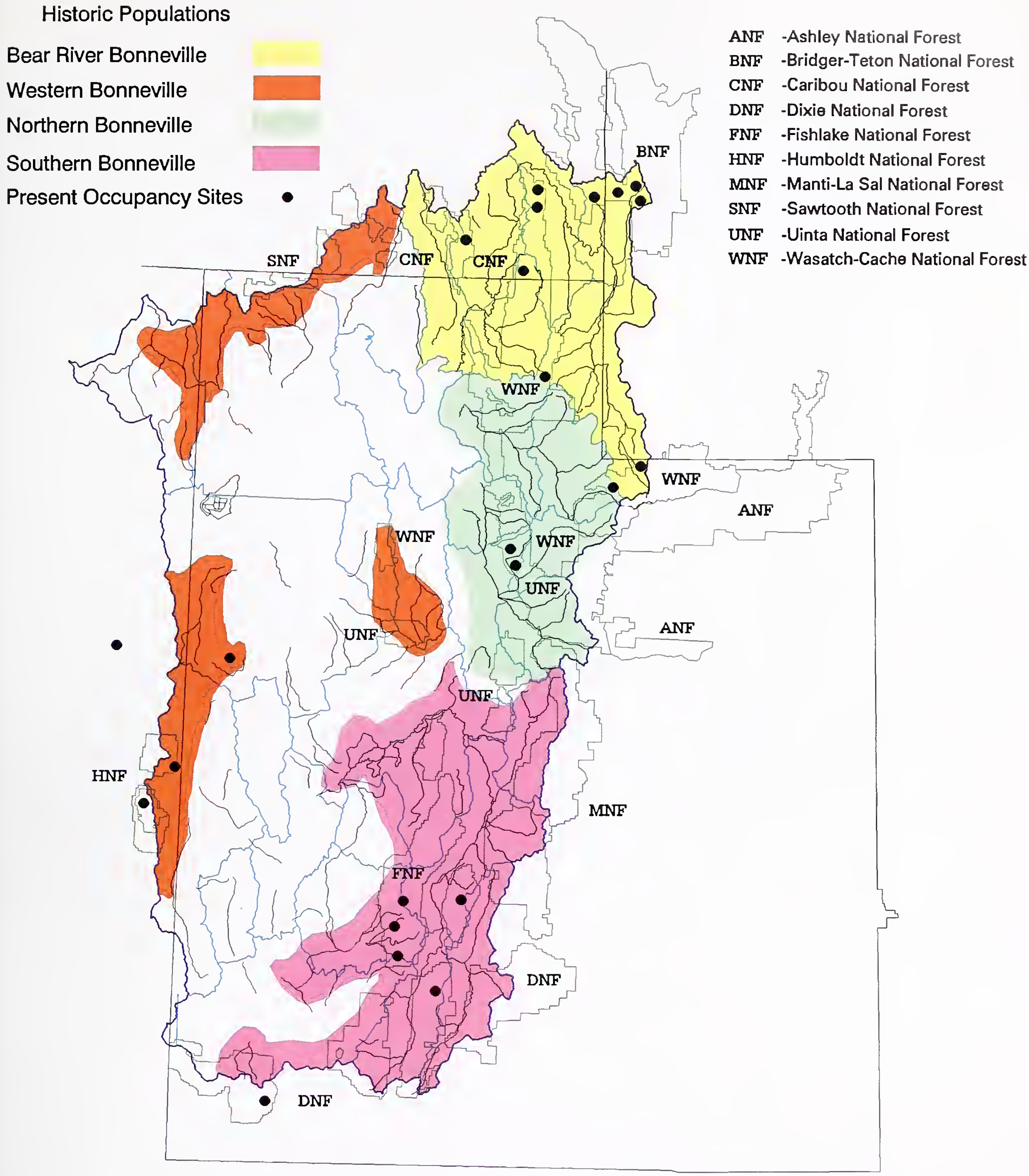

Figure 2. Bonneville Basin with locations of National Forests and Bonneville cutthroat trout historic population areas and occupancy sites.

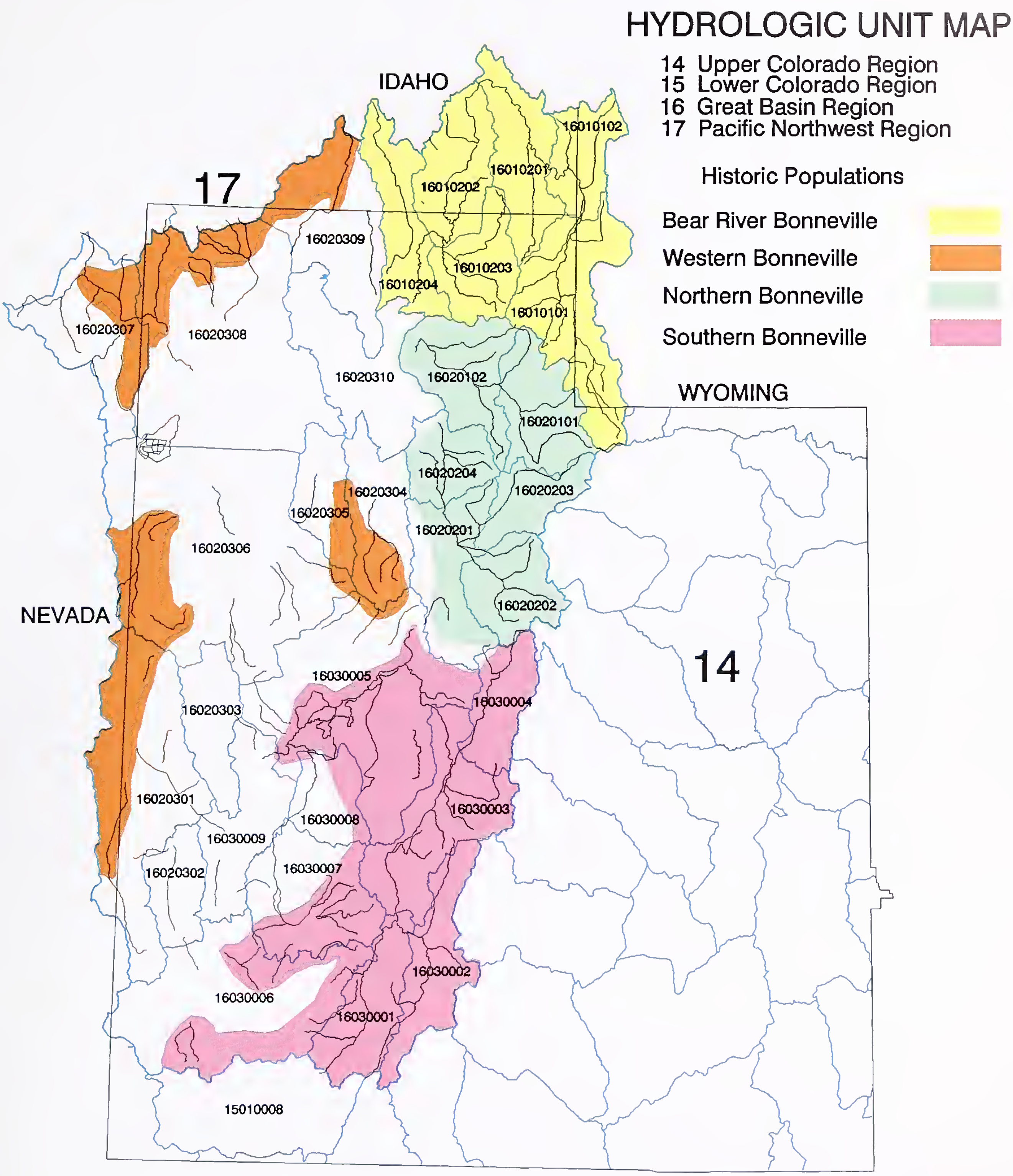

Figure 3. Bonneville Basin hydrologic sub-basins and Bonneville cutthroat trout historic population geographic areas.

separately for ease of reporting and because each State considered their populations as separate entities. In sub-basins outside Utah but within the Bonneville basin, the BCT historically occurred in 80% of Nevada sub-basins, and 100% of sub-basins in Idaho and Wyoming.

In recent times, since major settlement by European man in the mid-1800's, massive destruction of stream ecosystems and increased fragmentation of habitats occupied by the BCT has occurred. Primary causal agents of this destruction were stream water depletion and loss from irrigation diversions, dams, logging, mining, livestock grazing, roading, overharvest of fish, and massive basin-wide introductions of exotic (non-native) fish species (Popov and Low 1950, Behnke 1960, 1992, Sigler and Sigler 1986,1987). Millions of trout were stocked basin-wide from the late 1800's to 1950's by state and federal managers. The Forest Service (FS) was a willing partner in this stocking effort and in 1930 alone some 34.6 million trout were stocked by intermountain States on National Forests, with the FS stocking an additional 15.6 million that same year (USDA FS 1984). This indiscriminate and wide-spread stocking of exotic trout, especially rainbow trout since 1883, into virtually every habitable water body of the Bonneville Basin and their subsequent hybridization with indigenous BCT, coupled with habitat loss, was the primary cause for the almost complete elimination of pure BCT populations.

Habitat fragmentation and isolation in smaller headwater reaches of sub-basins contributed to the extirpation, over time, of BCT populations. As BCT populations became more isolated, through habitat loss, hybridization, and competition with introduced exotics, entire watershed and sub-basin metapopulations declined and finally were extirpated. Habitat fragmentation, loss of stream connectivity and disruption of aquatic ecosystems has been shown in other studies of trouts to increasingly isolate populations as well as isolate or eliminate unique life-history forms (Reiman & McIntyre, 1995). As a result of man's collective and cumulative activities BCT populations have been extirpated in 50% of the Bonneville Basin's sub-basins in Utah, 75% in Nevada sub-basins, 33% in Idaho sub-basins, and 50% in Wyoming sub-basins (Table 1).

The historic occurrence of BCT populations, by major basin and sub-basin, population, and by specific national forest and state is shown in Tables 2, 3, 4, and 5. The BCT has been extirpated in 67% of the total sub-basins of the Bonneville Basin on nine NF's. In Utah, the BCT has been extirpated in 76% of sub-basins on NFS lands of six NF's, and 43% of sub-basins on two Idaho NF's. Both Nevada and Wyoming NF's (Humboldt and Bridger-Teton) have BCT populations in each of their one sub-basins with NFS lands. Three NF's (Sawtooth, Uinta, and Manti-La Sal) have 100% extirpation of BCT in all thirteen sub-basins on NFS lands (Table 3).

This current assessment indicates (Tables 6, 6a-d) that approximately 5,131 perennial stream miles occurred in the Bonneville Basin, most of which may have been occupied by BCT populations. Current occupancy on NFS lands account for 67 pure BCT populations (includes 4 lake populations) in 190 stream miles. The total pure BCT populations within the basin, including all other lands, consists of 81 populations occupying a total estimated 234 stream miles. This total is based on estimates obtained from state and federal fisheries biologists. National Forest waters account for 81% of the known BCT occupied stream mileage habitat and 83% of BCT populations.

Historic NF stream miles account for 32% of the basin's total historic stream miles. Current occupancy by BCT on NF stream miles is only 3.7% of the basins total historic stream miles and only 11.5% occupancy of the total NF historic stream miles. It should be noted that most BCT occupancy is in fragmented habitats, in watersheds of marginal condition. Lost is connectivity to other populations which historically could have been present through metapopulation exchange in the basin. BCT populations are estimated to be 96% extirpated in Bonneville Basin historic waters and 87% extirpated in historic waters on NF's. These massive losses in BCT populations in previously occupied habitat,

on both NFS lands and other lands, has occurred only within the last 149 years, since settlement of the basin began. The protection of BCT occupied habitats and its genetic integrity should become, with a sense of urgency, a priority for agencies and managers accountable for species conservation and land stewardship.

Most of the 67 BCT populations on NFS lands have been genetically verified by one or more methods. Meristic analysis accounted for 87% of verification while electrophoresis accounted for 46%, and mDNA validation was completed on only 28% of the total BCT populations (Table 7). Origin of populations indicated 66% were from remnant BCT stocks and 34% represented transplanted populations from remnant stocks (Table 8). Most BCT populations were stream residents (94%). Streamflow depletion and habitat fragmentation are causal factors in elimination of the once prevalent populations of fluvial and adfluvial BCT. Abundance of BCT population numbers was indicated to be 69% common, 17% abundant, and 13% rare.

The presence of exotic fish in sub-basins with BCT populations continues to be a threat (Table 9). Exotic fish presence within sub-basins was based on visual observation, creel census, electrofishing, and stream restoration treatment. The exotic species present were: rainbow trout 67%, brown trout 51%, brook trout 9%, and other cutthroat trout (hatchery stock) 61%. The State of Utah is conducting a state-wide assessment of hatchery operations and stocking programs to assess the cumulative effects, by sub-basins, on indigenous cutthroat,i.e. BCT and Colorado River cutthroat trout (URMCC 1995). Utah and the FS are currently developing joint cooperative fish stocking policies on NFS lands, including wilderness areas, in order to ensure no further compromise of indigenous fish populations and habitats.

Partner conservation groups, like Trout Unlimited, National Wildlife Federation, Wilderness Watch, Utah Wilderness Association, Native Utah Cutthroat Association, and others continue to challenge state and federal agencies to change policies in order to protect indigenous cutthroat trout and other aquatic biota in threatened stream ecosystems (Duff 1995, Murray 1995, McGurrin, Ubert and Duff 1995).

Habitat condition and trend information was omitted in some questionnaire responses due to unavailable survey information. However, available condition and trend information linked to land-use activities indicated BCT habitat condition on NF's was 13% excellent, 49% good, 18% fair, 11% poor, and 2% extremely degraded. Where condition was reported for adjacent land ownership, within the watershed, only 3% was good condition, 6% fair, and 28% in poor to extremely degraded condition, and 63% in unknown condition. Trends in NF habitat condition indicated 19% in increasing stability, 58% stable, 7% decreasing stability, and 16% unknown. Adjacent land ownership indicated 21% in stable trend and 22% in declining trend and 57% in unknown trend. Condition and trend information is identified in tables for each specific BCT population by major geographic area.

Factors contributing to stream habitat condition and trends as a result of land-use activities, and specific causative activities were identified on most of the NF's. Those contributing to primary habitat degradation were sedimentation 68%, changes in channel morphology and lack of woody debris 28%, and dewatering 19%. Land-use activities causing these factors were identified as grazing 58%, roading 34%, and mining-logging, 4% each. Tables shown under specific populations identify these factors and activities by NF. While some ratings appear low when reported basin-wide, they indicate proportionally higher and more severe ratings for sub-populations, i.e. some NF's indicate 75-100% impact from sedimentation 44-89% impact from dewatering and channel morphology changes, up to 100% impact from grazing, 50% impact of mining and roading, and a 22% impact of logging.

Status of BCT population is indicated in tables for each population by their geographic area. Overall population status reported by this current assessment, as reported by state and federal managers, indicate 72% of BCT populations are in the "secure, stable" (SST) to "secure, expanding" (SEX) status (30% SEX; 42% SST) and 25% in "at risk, stable" (ARS) to "at risk , declining" (ARD) status (19% ARS; 6% ARD) The status of 3% of the populations was indicated as "unknown". Again, while overall status appears encouraging primarily due to BRB and SB population recovery efforts, the WB and NB populations show cause for concern as noted by assessment within their specific geographic sub-basin area. However, the BRB populations, which show close-relatedness to the Yellowstone cutthroat trout, as noted earlier, were to be classified as a separate subspecies in the future, the total numbers of remaining pure BCT within the basin proper would take on added importance and value for protection.

Western Bonneville

The assessment area includes that portion of the West Desert in Utah from the Raft River Range on the north to the Snake Range on the south including the Snake Valley portion of Pleistocene Lake Bonneville. Included within this area are portions of Idaho (the Black Pine Range and Northern Great Salt Lake Desert sub-basin) and portions of Nevada (the Pilot Range - Thousand Springs sub-basin and the Snake Range, and the Hamlin - Snake Valley sub-basin). Also included, for the purposes of this assessment are the isolated desert basins west and southwest of the Great Salt Lake with the Stansbury - Sheeprock Range on the east border. Four National Forests (Sawtooth, Wasatch-Cache, Uinta and Humboldt NF's) occur within portions of this area. This area encompasses nine sub-basins, seven of which the Western Bonneville cutthroat trout (WB) was present historically (Table 2).

Presently, the WB occupies only two sub-basins, both in the Snake Valley Bay arm of Lake Bonneville. The WB has been extirpated in 78% of the major sub-basins of its historical occurrence. Only two populations of WB occupy historic habitat in these two sub-basins, one on the Humboldt National Forest (HNF), Mt. Moriah Division, Nevada, and one on BLM land in the Deep Creek Range, Juab County, Utah. An additional three WB populations occupy stream habitat in the Spring-Steptoe Valley sub-basin, Nevada, outside the Bonneville basin. These transplanted populations occur in two streams on the west slope of Mt. Wheeler, Great Basin National Park (NPS) and HNF, and the other on one BLM stream to the north of Ely, Nevada. WB populations in the remaining three NF's, in the west desert sub-basins, have been extirpated (Sawtooth, Wasatch-Cache, and Uinta NF's). In the Bonneville basin only 6% of BCT on NFS lands are WB populations. The WB accounts for only 5% of total BCT populations occupying all lands in the Bonneville Basin.

Of an estimated 427 historic perennial stream miles in the WB sub-basins less than one percent (0.009) is occupied by two populations on the HNF (Tables 6, 6a). This amount includes an estimated total 277 historical stream miles in the Snake Valley sub-basins (56.5 miles on HNF), 70 stream miles in three sub-basins adjacent to the Raft River Black Pine Ranges (27.5 miles on Sawtooth NF) and 80 stream miles partially in four sub-basins surrounding the Stansbury - Sheeprock Range (49 miles on Uinta NF and 31 miles on Wasatch-Cache NF).

Based on historic perennial stream occurrence, the assessment estimates that 90% of those stream miles contained WB in all suitable waters; now 99% of the WB populations have been extirpated in perennial streams in the seven WB sub-basins. Existing streams on the four NF's have an estimated 132 stream miles, of which only 3.2% is occupied by two WB populations. The WB is extirpated on 96% of NF streams on 4 national forests. There is little historic information that quantifies trout abundance; most historic references provide an indication that trout were common in many perennial

stream reaches (Behnke 1976, 1992, Brooks 1989, Hickman 1978, Thwaits 1907, Jordan and Evermann 1908, Suckley 1874, Yarrow 1875, Cope 1955, Dodge and Cain 1970).

The Snake Valley sub-basins contain the most studied WB streams of the seven historically occupied basins (Behnke 1976, Hickman and Duff 1978, Duff 1988, Haskins 1993, 1987). Based on this information an estimated 277 perennial stream miles could have been present within these two sub-basins. Multi-land ownership information is included in this estimate, including NF, BLM, State, and private lands. In Nevada, only one WB populations on the HNF is a remnant population while the remaining three (and 1 BLM population) are transplants from remnant populations in the Snake Valley area. While in Utah, two remnant populations occupy BLM lands in the Deep Creek Range (Behnke, 1976). The author discovered the two populations in the Deep Creek Range in 1974 following intensive surveys of WB historic habitats begun in 1972 in coordination with Dr. Robert Behnke, Colorado State University. Another "possible" WB population was discovered in the Pilot Range sub-basin in 1975, however, population sampling by the Utah Division of Wildlife Resources (UDWR) was not conducted until 1978; then meristic analysis by Dr. Rober J. Behnke confirmed this remote, sparse population to be a genetically pure Lahontan cutthroat trout of Pyramid Lake origin (Hickman and Behnke 1978, Hickman and Duff 1978).

Considering recovery in the Snake Valley sub-basins, the WB currently occupies only 1.5% of its historic habitat. As an example of WB recovery needs, an estimated 102 stream miles (47 miles on NF, 25 miles on NPS, 27 miles on BLM, and 2.5 on other lands) are estimated to be needed for viable WB population recovery based on historical and current stream information, and the author's professional experience in the area. The HNF stream mileages would account for 46% recovery while NPS could provide 24% of stream recovery. The NPS stream miles were historically administered by the HNF ownership until the creation of Great Basin National Park in 1986. Prior to 1986, the amount of WB NF historic habitat could be stated as 29% in Snake Valley, with a population occupancy of only 5% and a population extirpation of 95%. In addition, recovery potential for WB could be enhanced in cooperation with the Goshute Indian Tribe which indicates an estimated availability of 30 historical stream miles in the Deep Creek Valley portion of the Southern Great Salt Lake sub-basin (personal communication, Buzz Cobell, U.S. Fish and Wildlife Service).

Current habitat assessment for the two occupied sub-basins' overall habitat condition is fair to good, and the trend is stable (Table 10). The HNF sub-basins rated as 50% good and 50% fair habitat, with grazing occurring on 100% of occupied streams and mining on 50%. There is also a significant uncertainty relative to condition and trend. Specific comments pointed to on-going land activities, i.e. mining, grazing and roading, coupled with stream de-watering, changes in channel morphology, and terrestrial erosion - instream sedimentation as major factors influencing habitat (Table 11). The two WB populations (one remnant and one transplanted) on HNF within the Bonneville Basin could be classed as having a "at risk, stable" (ARS) status due to these on-going activities. The three WB transplanted populations outside the Bonneville Basin have a "stable and expanding" (SEX) populations; the two populations in the Deep Creek Range could be classed as "at-risk, declining" (ARD), but on-going and future management by state and federal agencies could enhance the stability of these populations (Table 12).

Genetic verification has been completed on all populations on HNF through meristic and electrophoresis evaluation. The one remnant HNF population has been verified genetically pure through mDNA analysis (Table 7). Rainbow trout and other hatchery cutthroat were identified as exotic species and a threat to WB population recovery in all seven sub-basins. These exotic species were present in five sub-basins (71%) including the two sub-basins occupied by WB populations. Hybridization with exotics and mining are viewed as major threats to existing WB populations. Some quantification of population status is available from state wildlife agencies, in Nevada and Utah, but

most information in questionnaires was based on qualitative appraisal of habitat and population health. Existing habitat conditions on NF's (Sawtooth, Wasatch-Cache, and Uinta NF's) while not rated in the questionnaire can be estimated to be in poor to fair condition resulting from land-use activities, such as, grazing, roading, and mining, with primary contributing factors of de-watering, channel morphology and streambank change, and streambed sedimentation (personal communication, national forest biologists and state fisheries managers, 1995). The loss of species bio-diversity is considered by many scientists to be resultant from anthropogenic habitat fragmentation and is the single greatest threat causing this loss (Noss 1991).

Current management opportunities for recovery of existing WB populations are identified in a specific interagency habitat management plan for Nevada populations (Haskins 1987), a Utah conceptual plan for native fishes (Schmidt et al. 1991), a draft Utah BCT conservation agreement and strategy (UDWR 1996), and HNF Forest Plan and wilderness area management goals and guidelines (Whelan 1993). Previous evaluations of WB populations document their uniqueness and differentiation from other sub-populations endemic to the Bonneville Basin (Behnke 1976, Duff 1977, Hickman and Duff 1978, Shiozawa, Evans, and Williams 1992).

The genetics of the WB represent the most relict, pure form of BCT and management programs should protect and maintain its genetic integrity. Assessment data and management history suggests the Snake Valley populations are the most threatened individual population segment of the BCT in the Bonneville Basin. Due to BCT inter-population differences within the Basin any efforts for recovery of WB populations should be focused on genetic potentials originating in close geographic proximity to the source population (Shiozawa and Evans 1992). For example, in order to protect the unique genetic lineage of the WB, populations of the WB and NB should not be intermixed to accelerate expansion of the WB range. The presence of anthropogenic activities that continue to subject WB populations to habitat fragmentation greatly increases its chances of extirpation. Management guidance at national levels has indicated that, for species survival, responsible managers must treat the causes of habitat disruption rather than just the symptom (National Research Council 1992).

Bear River Bonneville

This assessment area includes all six sub-basins within the Bear River drainage to the Great Salt Lake. The area contains populations of BCT designated herein as Bear River Bonneville (BRB). Sub-basins are differentiated by two upper Bear River basins (in portions of Utah, Wyoming and Idaho) and four middle and lower basins (in portions of Idaho and Utah). BRB populations will be discussed by State and by sub-basin occurrence. The BRB historically occurred in all six sub-basins, but currently occupy 83% of historic sub-basins, and are extirpated in one sub-basin (Table 2,3).

The amount of historic sub-basin habitat was estimated at 1,958 stream miles. National Forest (NF) historic stream miles (Bridger-Teton, Caribou and Wasatch-Cache NF's) account for 29% of total historic stream miles. (Table 6b). A total of thirty-six genetically pure BRB populations occur, including one lake population (Lake Alice, WY, 231 surface acres). These populations occupy only 7% (140.5 stream miles) of total historic habitats and 25% of NF historic habitat (568 stream miles) in the six sub-basins. Based on the assumption that BRB occupied most usable perennial stream habitat on NF's, it is estimated that BRB populations are 65% extirpated on NF's, and 92% extirpated in historic waters in the six sub-basins. As more quantifiable information becomes available in the future refinement of occupancy, status can be ascertained with more certainty.

The Central Bear sub-basin (Idaho and Wyoming) of the upper Bear River basin is presently inhabited by 27 BRB populations (including 1 lake) occupying 77% of NF's historic habitat. (Table 6b). These occupied habitats occur within the Smith's and Thomas Fork's of the Bear River in Wyoming and Idaho (Binns 1981). These watersheds also contain eight populations on BLM lands. Overall population status within the sub-basins was indicated to be "at risk, stable" (ARS), with Wyoming populations (Bridger-Teton NF) estimated 95% "secure, stable" (SST) while Idaho populations (Caribou NF) were estimated 33% as "at risk, stable" (ARS) and 67% in the categories of "unknown" to "at risk, declining" (ARD) (Table 16). Within the sub-basin, in Idaho portion of the upper Thomas Fork, three BRB populations occur, two of which also have occupied habitat in Wyoming (Bridger-Teton NF), but for purposes of this assessment reporting will be listed as separate populations, as identified by state wildlife agencies (personal communication Ron Remmick, Wyoming Dept. Game and Fish). Status of three BRB populations in Idaho are considered "at risk, declining" (ARD) due to human activities. The Idaho Department of Fish and Game and the Caribou National Forest have implemented a joint conservation strategy to conserve and protect these populations (Skully 1995). Wyoming BRB populations are being managed jointly under the interagency five-year management plan (1993-1997) which includes all populations on NFS and BLM lands in this sub-basin (Remmick et al 1994).

Habitat condition and trend indicates that 95% of habitats are in good condition and 5% fair on the Bridger-Teton NF, while habitat trend is 100% stable on all streams (Table 17). Information on lands outside NF boundaries is incomplete, but that available indicates some is in fair to poor condition with a decreasing trend. Sedimentation is noted as affecting 100% of BRB populations. Other factors affecting habitat condition are dewatering (13%), and changes in stream morphology and lack of woody debris, both 14%. Land-use activities contributing to these factors were identified as grazing (91%) and road construction (68%). Rainbow trout occupy 100% of BRB population habitats in the Smiths and Thomas Forks, while brown trout and other hatchery cutthroat trout occupy 82% and 99% respectively of the same habitats (Table 9). The presence of these exotic fishes are viewed as a threat to all BRB Wyoming populations. However, previous genetic research has indicated the unique ability of this population to exist with limited introgression, a factor that is not present in most other BCT populations within the Bonneville Basin (Martin and Shiozawa 1982, Behnke 1980, 1992, Nelson 1990, Remmick 1994, Shiozawa and Evans 1995).

The upper Bear River sub-basin in Utah, contains five known pure BRB populations all of which occupy habitat on the Wasatch-Cache NF (Tables 4,5). Current assessment information indicates about 352 historic stream miles with 70% occurring on NFS land. Current occupancy of BRB populations is limited to only 1.9% of NF historic habitat. Occupancy indicates that BRB populations have been eliminated from about 80% of NF historic habitat upstream of Evanston, WY, and 91% extirpated from total historic habitat. Within the sub-basin from Evanston downstream to the Central Bear sub-basin boundary, only one BRB population occupies NFS land (Wasatch-Cache NF). In this reach of the sub-basin, it is estimated, based on stream mileage and occupancy, that BRB populations have been extirpated in 98% of total historic waters, and 75% extirpated on NFS lands. Population status of all five BRB populations on the Upper Bear sub-basin is indicated to be "at risk, stable" (ARS) (Table 6b).

Habitat condition on the Wasatch-Cache NF was indicated to be fair to poor with a stable, but tending toward declining trend. All five BRB populations were stream resident and trends in abundance were stable to declining while distribution was declining. Exotic fish, primarily rainbow and other cutthroat, were present in all occupied waters and viewed as a threat. Factors affecting habitat condition in the streams were sedimentation (100%), channel morphology changes (60%), increased water temperature (100%), lack of woody debris (60%), and dewatering (60%). Activities affecting habitat condition were indicated to be grazing (100%), roading (80%), and logging (40%) (Table 15).

The BRB also occupies habitat off the NFS lands in Bear Lake on the Utah-Idaho stateline. It presence provides the States of Utah and Idaho with many management opportunities to recover BRB populations (Nielson and Lentsch 1988). A cooperative effort between Utah and the FS provided Bear Lake Bonneville to the Strawberry Reservoir, Wasatch County, Utah. While outside its historic range, this transplant was designated as a management population for recreational purposes. An additional transplant of a pure population on the Wasatch-Cache NF, Rich County, Utah, was made to suitable waters on nearby Deseret Land and Livestock Company lands for both management and conservation purposes (UDWR 1996).

The Lower Bear River basin consists of four sub-basins covering watersheds on the Bear River from Soda Springs, Idaho, to its entry into the Great Salt Lake. Approximately 1,323 historic stream miles occupy these sub-basins with 27% occurring on NFS lands in two NF's (Caribou and Wasatch-Cache NF's) (Table 6b). The assessment indicates the occurrence of six pure BRB populations inhabiting 5% of NFS land on the Caribou NF (18 stream miles). Population occupancy is only 1% of total historic habitat. Based in stream mileage and occupied habitat, BRB populations are estimated to be 85% extirpated on NFS lands and 87% extirpated within their historic range in all sub-basin waters. The occurrence of six BRB populations in three of the four sub-basins should not be viewed as a indication of overall population health within these watersheds. BRB occupancy is fragmented, isolated, and contains marginal habitats with status as "at risk, declining" (ARD). Recent genetic evaluation of these populations indicate their relative purity to bear resemblance to a remnant form of the BCT, but subject to continued threats from exotic species (hybridization) and human activities (dewatering channel morphology changes and grazing). BRB populations on the Caribou NF, have a status 45% "at risk, stable" (ARS) in 50% of the sub-basins and 33% "at risk, declining" (ARD) in 25% of the sub-basins. Two populations have "unknown" status in 2 sub-basins (Table 19).

Habitat condition on BRB populations on the Caribou NF indicate 78% occupy fair habitats and 22% occupy poor habitats (Table 20). Habitat trend indicates 44% are stable with the status of 56% unknown. Factors indicated affecting habitat condition were identified as sedimentation (100%), water temperature (78%), channel modification (66%) and lack of woody debris (56%). Grazing occurred on 78% of habitats and was indicated as the primary cause of habitat deterioration (Table 21). The presence of exotic fish, i.e., rainbow, brown and other cutthroat trouts which occupy same or adjacent accessible waters, is viewed as a threat to all Idaho populations (Table 9). Past and present inventories continue to provide information on presence and absence of BRB populations to help clarify the uncertainty of their status and distribution (Cowley 1995, Nielson and Lentsch 1988, Behnke 1980, Behnke and Proebstel 1995, Nelson 1990, Brown 1935).

Overall BRB population status within five occupied Bear River sub-basins indicates all are "at risk", with the upper two sub-basins categorized "stable" (ARS) and lower four sub-basins categorized "declining" (ARD) status. Genetic verification has been accomplished for 37% BRB populations overall with meristic evaluations at 92%. Meristic evaluation for BRB populations on the Bridger-Teton NF are 100% complete, on the Caribou NF 89%, and the Wasatch-Cache NF 80%. Electrophoresis analysis accounts for only 22% of total populations but varied from Bridger-Teton NF (5%) to Wasatch-Cache NF (80%), with none completed on the Caribou NF. Only 5% of the BRB populations have had a mDNA analysis completed. The Wasatch-Cache NF populations indicate 40% mDNA validation with none completed on the Caribou and Bridger-Teton NF's.

Northern Bonneville

The assessment area includes that portion of the eastern Bonneville Basin bordered on the north by the Weber River sub-basin and the south by the Spanish Fork-Utah Lake sub-basin. The area

includes six sub-basins all of which flow into the Great Salt Lake. All sub-basins historically contained populations of BCT referenced herein as, northern bonneville (NB) populations to segregate them geographically and genetically from other BCT populations. (Table 2). All four known NB populations occupy habitat in two sub-basins on the Wasatch-Cache National Forest (NF). No NB populations are known to occur in four sub-basins on three NF's (Uinta, Manti-LaSal, Wasatch-Cache) and are thought to be extinct on NFS lands in these sub-basins. The NB has been extirpated in 67% of the six sub-basins in which they occurred historically (Table 4,5). Only 6% of BCT populations on NFS lands in the Basin are NB populations. The NB populations account for only 5% of total BCT populations occurring on all lands in the Bonneville Basin.

The historical occurrence of the NB populations has been documented extensively. Mention of its distribution, abundance, and size is common in early records, dating back to 1776 (Auerbach 1943, Stansbury 1860, Simpson 1876, Thwaits 1907, Hickman 1977, 1978, Behnke 1992). Some examples of historical occurrence is provided from the literature to show BCT distribution in this sub-basin.

In 1776, the Escalante-Domingez Expedition, from Santa Fe penetrated the region. They noted Indian tribes camped on the shores of Utah Lake (Lake Timpanogos) drying hundreds of salmon-like fish taken from the lake and streams (USDA FS 1984). Numerous emigrant guides and government and scientific explorations reports mention the occurrence and abundance of trout and salmon-trout like fish in Bonneville Basin streams (Hastings 1845, Madsen 1910, Auerbach 1843, Pratt 1970, Suckley 1874, Yarrow 1874, Sigler and Sigler 1987). Emigrant journals from wagon trains bound for Oregon and California passing through Echo Canyon-Weber River drainage mention trout abundance, many in the 3 to 5 pound size. Brigham Young's Mormons established a "commercial fishery" in 1849 to utilize the native cutthroat trout of Utah Lake and its tributary streams to "harvest" fish (in sizes up to 40 pounds) for sustenance and survival (USDA FS 1984, Cleland and Brooks 1983).

However, despite the BCT historic distribution and abundance, human activities, through settlement, began its immediate and rapid decline in the northern bonneville area. This decline has been noted by many others (Cleland and Brooks 1983, Pratt 1970, Cottam 1947, Hickman 1978, May et al 1978, Duff 1988, Behnke 1992, Kershner 1995). Widespread changes in channel morphology through overharvest, irrigation diversion (beginning in 1847), increased competition and hybridization with exotic fish introduction of disease, destruction of riparian streambank and instream habitat through livestock grazing, were the primary causal agents leading to the demise of NB populations (Cottam 1947; Behnke 1992; Popov and Low 1950).

Introductions of exotic fishes into watersheds of the Utah Lake - Great Salt Lake drainage began in 1871 and include species such as shad; rainbow trout; salmon; carp; brook, brown and other trouts; char; and a variety of warm water fish. These species also contributed to the major decline and elimination of NB populations (Popov and Low 1950; Deseret News 1883). Brigham Young was quoted as speaking pathetically of the destruction of City Creek waters (in Salt Lake City), willows, and wild roses growing thickly on its two branches which were destroyed because the "channels must be changed" for agricultural purposes (Cottum 1947). Channel changes and water diversions were primary causes for elimination of BCT populations in the City Creek drainage. As Governor for the newly formed State of Deseret, Utah Territory, Brigham Young's first law, enacted in 1853, authorized counties jurisdiction in fisheries to provide regulations to "successfully prevent the needless destruction of fish", since the native trout (BCT) were a key food staple for the Mormon pioneers survival in their early settlement years. Yet, despite this concern, and the "law", man's activities continued to further the demise of the native trout fisheries, leading to their eventual extirpation in the Jordan River sub-basin (Rawley 1985).

The Forest Service (FS) and state wildlife agency later contributed to this impact and furthered the BCT decline by significant increases in fish stocking activities on national forest streams and lakes, including waters off NFS lands. In 1930, some 34.6 million fish were planted on NFS waters alone. The NB cutthroat became extirpated in the Utah Lake system in the early 1930's, a victim of wide-spread harvest, exotic introductions, and habitat-flow loss through irrigation diversions (Cope 1955, USDA FS 1984, Hickman 1978).

The historical NB riverine habitat was estimated by this assessment at 1,178 stream miles within the four major sub-basins (Table 6c). About 38% of these stream miles were historic habitat on three national forests (Wasatch-Cache, Uinta, and Manti-LaSal NF's). Occupied habitat occurs only on one NF totaling 7.5 stream miles for four known NB populations, of which two are remnants and two are transplants from remnant stocks (Table 4,5). These existing populations occupy only 1.6% of historic national forest habitat. Human activities have caused extirpation of NB populations over an estimated 99% of historic sub-basin waters, and 98% on national forests waters. One NB remnant population recently discovered occurs off national forest lands in the Parley's-Lambs Creek watershed, Jordan River sub-basin (Woolf 1995). Expansion of this population onto the Wasatch-Cache NF in this watershed is probable in the future through State management actions. The status of two NB transplanted populations was recorded as "secure, expanding" (SEX). These populations in the Wasatch-Cache NF, occur in a reservoir and stream within the Red Butte Natural Research Area, a protected NF watershed. However, the reservoir could be eliminated in the future due to structural instability, therefore, severely reducing the BCT population and its use as a brood stock area. Habitat condition is indicated as "good" and trend in abundance is "increasing" (Table 13). Status of the two remnant populations, one each in the Weber River and Jordan River sub-basins is "at-risk, declining" (ARD) in the Weber River and "secure, expanding" (SEX) in the Jordan River. National forest activities and man's encroachment continue to place these populations "at-risk". While habitat trend is "stable" for both populations, overall condition varied from "fair" for the Weber River to "good" for the Jordan River populations.

All four populations have had genetic evaluation completed (100%) for meristics and electrophoretic validation as pure populations, and 75% have been validated with mDNA (Table 7). Exotic fish, primarily rainbow trout and other cutthroat trout are present in or immediately adjacent to 100% of the occupied habitats, and are viewed as a threat to all populations. All populations are considered resident in streams, and all are rare in abundance. Habitat condition factors have not impacted two of the three Jordan River sub-basin populations. But one population, in and adjacent to the Twin Peaks Wilderness, is subject to angling pressure and declining population. The Weber River population is affected by dewatering, lack of woody debris, changes in channel morphology, and streambed sedimentation, primarily associated with livestock grazing activities (Table 15).

There is still considerable uncertainty regarding possible suspect NB populations. Two populations (Ogden and Spanish Fork sub-basins) are suspect but need further genetic evaluation to ascertain pure status. Initial genetic testing is cautious in assuming purity because of possible intermixing and close association with Yellowstone cutthroat trout and BRB populations (Dennis Shiozawa, Brigham Young University, personal communications 1996). But efforts are underway by the Wasatch-Cache NF and Utah Division of Wildlife Resources to investigate certain additional waters as part of the BCT conservation strategy for Utah (UDWR 1996).

Southern Bonneville

The assessment area includes that portion of the Bonneville Basin within the Sevier River and Escalante Lake sub-basins in south-central Utah. Included within this historic habitat range are nine

sub-basins of which the Southern Bonneville cutthroat trout (SB) occupied eight sub-basins or 89% sub-basin occupancy. The assessment indicates these eight sub-basins have occupied habitat for thirteen SB populations (11 stream and 2 lakes). An additional ten SB populations occur in one sub-basin outside the Bonneville Basin, the Upper Virgin River sub-basin (Table 2). Currently, SB populations occupy 50% of historic sub-basins being present in four of the eight sub-basins.

Two of these upper Virgin River populations are considered remnant populations. Their occurrence has been purported to be as a result of introductions by early settlers into the area in the mid-to-late 1800's through a low-elevation, upper headwater transplant from the Bonneville basin (Behnke 1976, 1992). Another explanation may be a natural geologic stream capture event caused by volcanic activity within the last 2,000 years B.P. which diverted portions of the Grass Valley-Pine Valley area into the Santa Clara River watershed within the upper Virgin River sub-basin (Dale Hepworth, Utah Division of Wildlife Resources, personal communications 1996). Reports of early pioneer observations of native trout in the upper Santa Clara River date back to 1863 (Miller 1961). Given the reported abundance by Miller, Hepworth speculates that there would not have been enough time for the trout to reach those numbers in such a short time period if the pioneers had recently transplanted them. Hepworth bases this on abundance and distribution data available for known SB populations (Hepworth, personal communication, 1996). The remaining eight populations were transplants from the two remnant populations in the late 1980's-1990's. All SB transplant populations in the upper Virgin River have been replicated from existing pure populations within that sub-basin. Hepworth estimates that 25 historic stream miles occurred in the historic natural stream capture event. The cooperative program between the UDWR and Dixie NF for management and conservation of SB populations continues to be implemented (Hepworth, personal communication 1996, Schmidt et al. 1995, Duffield 1990).

The assessment indicates an estimated 1,565 perennial stream miles historically occurred in the eight sub-basins (Table 6d). An estimated 492 stream miles (31%) historically occurred on NFS lands on four NF's. Current occupied habitat occurs on only 7.6% of NF historic habitat for the twenty-three SB populations on two NF's (Fishlake and Dixie NF's). The SB populations are not known to occur (thought to be extirpated) in historic habitat on the Uinta and the Manti-LaSal NF's in two middle Sevier River sub-basins (Tables 3,4,5). Based on historic stream mileage and current occupancy, the assessment indicated that SB populations have been extirpated on 98% of the basins historic stream miles and 91% of NF historic stream miles. This includes the ten SB populations (remnant and transplants) occupying waters on the Dixie NF in the Upper Virgin River sub-basin as a result of a possible natural stream capture event.

Historical references relating to SB population occurrence and distribution is available but largely qualitative (Hickman 1978). Observations of native cutthroat trout in streams were noted by early European explorers beginning in 1776, and continuing through the early years of exploration and settlement of Utah Territory in the mid-1800's by government surveyors and Mormon pioneers (Cleland and Brooks 1983, Madsen 1910, Behnke 1960, Brooks 1989, Popov & Low 1950). Scientific interest in protection and conservation of BCT subspecies led Dr. Robert Behnke, Colorado State University, to initiate surveys in the early 1970's to document occurrence and distribution of BCT in the Bonneville Basin (Behnke 1973). The author began similar investigations at the urging of and in cooperation with Dr. Behnke in the early 1970's along with other federal and state biologists. These joint investigations led to increased discoveries of and management for BCT populations (Duff et al. 1974, May 1977, May et al. 1978, Hickman 1978, Behnke 1973, 1978, Schmidt et al. 1995).

In 1973, only three BCT populations were known to occur in southern Utah, one occurring in the Beaver sub-basin (Fishlake NF) and two in the Upper Virgin River sub-basin (Dixie NF). These three populations accounted for only seven stream miles of which the one population within the Bonneville

Basin would account for less than 0.002% of total historic stream miles. Expansion of the existing range of SB populations and discovery of additional populations has been accomplished through cooperative interagency efforts by Dale Hepworth, Utah Division of Wildlife Resources (UDWR). This assessment indicates overall population status of 23 total SB populations to be "secure, stable" (SST) due to transplants into the historic range (Table 2).

Five of the SB populations are remnant (2 on Fishlake NF; 3 on Dixie NF), and eighteen are transplanted (7 on Fishlake NF; 11 on Dixie NF). Two transplanted populations in the Fishlake NF are lake-reservoir populations (Manning Meadow Lake and Barney lake) totaling about 76 surface acres. Existing habitat occupancy in four sub-basins, on two NF's (Fishlake & Dixie NF's) indicate 45% occupancy in thirteen streams within the 47.1 total stream miles renovated. Expansion of SB populations in these waters will continue in these renovated habitats for the remaining 55% of available habitat ensuring "stable, secure" (SST) population status, as well as increasing their use as "brood stock" sources for future renovation-expansion activities (Dale Hepworth UDWR, personal communication, 1996). Hepworth estimates that 25 stream miles in the upper Virgin River sub-basin could have been present historically when a natural geologic stream capture event possibly occurred. Currently, these ten populations on the Dixie NF occupy 16.2 miles of habitat of a total 33 stream miles suitable habitat available. This is 49% stream occupancy but these secure, stable populations that will expand their range into the unoccupied, and available habitat. According to Hepworth, this population of SB will only be used for transplants within the sub-basin of its occurrence. It would not be transplanted into the Sevier River sub-basin, thereby protecting genetic diversity of BCT populations within major sub-basins.

Genetic verification of the twenty-three SB populations indicate validation for meristics at 74%, electrophoresis 78%, and in DNA 52% (Table 7). Population status of nine populations on the Fishlake NF indicate 67% "secure, expanding" (SEX), and 33% "secure, stable" (SST) and 7% "at risk, declining" (ARD). Threats from exotic fish presence is minimal, possibly less than 5% since stream rehabilitation and barriers have eliminated past threats to populations from hybridization and competition-displacement (Table 9).

Current habitat assessment for SB populations indicate 39% in excellent condition (64% Dixie NF), 31% good condition (21% Dixie NF; 67% Fishlake NF), 22% fair condition (33% Fishlake NF; 14% Dixie NF), and 4% each in poor to extremely degraded condition (Dixie NF). Overall habitat trend indicates increasing habitat availability at 52% (57% Dixie NF; 44% Fishlake NF), stable habitat at 26% (21% Dixie NF; 33% Fishlake NF), and 22% is "unknown" trend (22% Dixie NF; 21% Fishlake NF). Habitat condition on lands adjacent to NF's were estimated to be extremely degraded (39% +) with greater than 43% trending toward declining condition (Table 13).

Factors affecting habitat condition were sedimentation 26% (Dixie NF at 36%; Fishlake NF at 11%), and changes in channel morphology, dewatering and lack of woody debris 39% (Dixie NF at 36%; Fishlake NF at 44%) (Table 15). Land use activities contributing to these factors and conditions were grazing 17% (Dixie NF at 14%; Fishlake NF at 22%), logging 11% (Fishlake NF), and roading 14% (Dixie NF).

MANAGEMENT IMPLICATIONS

The future survival of the BCT within the Bonneville Basin will depend on interagency and inter-state coordination of all responsible state and federal agencies, interested groups, and the public. Each of the four states (UT, NV, ID, WY) BCT species management plans and individual Forest Plans of the nine National Forests must serve as the catalyst for implementing species recovery and habitat

restoration within the Basin. Species and habitat specific management and monitoring protocols must be coordinated, implemented, and integrated within all geographic areas of BCT occurrence within the Basin to assure a viable basin-wide recovery.

Consistent with the above mentioned management, supplemented species conservation agreements (CA) and strategies (CS) must be developed. These CA/CS's should be developed by state(s) to address BCT management within their geographic area, as well as coordinated and agreed upon between States that share common sub-basins within the Bonneville Basin. As shown with this assessment, the activities and factors which have caused the decline of BCT populations and habitat continue to occur, some showing no sign of abatement. As human population growth increases within the Basin, more demands will be placed on water, timber, range, riparian, and other natural resources. The cumulative impacts of habitat degradation and species harvest and hybridization will continue to reduce the distribution and abundance of BCT, and could force many distinct, and geographically isolated populations of this sub-species into extinction. Principle management components and specific guidance based on the findings within this assessment can be categorized into three groups: A) protection, B) enhancement, and C) restoration.

A) PROTECTION

Agencies priorities must be focused on protecting existing populations and occupied habitats of the BCT. It must be incumbent on the management agencies, (i.e. Forest Service, BLM, and States) to provide responsible land and water stewardship and management accountability if these populations and their individual (or geographic area) genetic integrity is to be protected. Protection includes all forms of aquatic fauna and flora associated with these aquatic ecosystems, including invertebrates, amphibians, and other freshwater fish. Protection implies elimination of or reductions in all detrimental influences on habitats and populations. It is also implicit that the management agencies gives preferential management to the subspecies across its range when conflicting activities place the BCT at risk.

1. Genetic purity of BCT populations must be ascertained and monitored to assure continued genetic integrity of specific basin-wide populations. Genetic validation should include meristics, electrophoretic and mDNA assessment. This will provide a more thorough understanding of population relationships with geographic isolation patterns, since some data included in this assessment are based on meristics only. Until more information is known about subspecies genetic relationship within the basin, genetic integrity of existing populations should be maintained, i.e. stocking of the sub-species outside of the major sub-basin of occurrence should not be considered.

2. A statewide and/or geographic area-wide assessment of state hatchery and stocking practices and protocols will benefit protection of the BCT. Since the late 1800's, fish hatcheries and stockings of non-native and exotic fish have contributed to massive hybridization of indigenous BCT populations. The introduction of non-native species has contributed to partial and/or total displacement and loss of BCT populations throughout the Bonneville Basin. In recent years, cultured non-native trout have contributed not only to this "genetic pollution" but also have increased disease risk, (i.e. whirling disease), increased competition and displacement, masked the problems associated with habitat destruction and loss, and marked overharvest. A state-lead cooperative interagency assessment of hatchery and stocking programs would insure that non-native trouts and hatchery programs do not impact nor occur in waters within sub-basins presently occupied by the BCT, or in waters where restoration activities are planned. Such an assessment will increase the efficiency of the State to provide pro-

grams to recover indigenous trout, enhance wildtrout fisheries, and operate hatcheries for recreational fishing waters. Assessments linked to conservation strategies and plans will help both state and federal agencies to work as partners in joint fisheries and habitat management programs (URMCC 1995).

3. Habitat protection through agency stewardship and decision making is essential to maintain existing populations in occupied habitats. Since streams follow no "political" boundary, agencies need to coordinate basin-wide strategies and programs. An ecosystem approach must be taken to protect and maintain aquatic biodiversity and viable populations. Interstate, as well as in-state agency coordination is necessary, as is agency accountability in decision-making. Since most existing BCT populations are found in small, headwater streams on National Forests, including wilderness and roadless areas, it is incumbent on the Forest Service to judiciously restrict land use activities that may pose habitat disruption and loss, or tend to place the populations further at risk. Protection of BCT populations in the future will primarily be dependent on federal agency management for healthy aquatic ecosystems, i.e. stable watershed soils, rooted terrestrial and riparian vegetation, and clean water (quality and quantity).

4. Regulatory mechanisms need to be employed where necessary, to ensure population protection and genetic integrity. Stream closures, total or partial, as well as harvest regulations as developed by the States need to be considered and implemented, where necessary. Both population and habitat specific area relationships need to be reviewed and jointly agreed upon by state and federal managers. This will ensure BCT protection, especially where access, facilities, and user pressure are viewed as possible risks to the subspecies.

B) ENHANCEMENT

Agency emphasis should be toward providing management activities and decisions that provide habitat enhancement so as to ensure long-term maintenance of reliable pure populations. Conservation enhancement should require maintenance of multiple local or sub-basin populations. Overall ecosystem sub-basin health is important to proper aquatic ecosystem function and processes. Any activities which allow habitat disruption and/or fragmentation that threatens the diversity, stability, and persistence of pure populations should not be allowed. Management decisions made on the basis of phylogeographic interpretation of extant patterns of biological diversity will both promote and protect natural processes which have and will continue to mold the genetics of pure cutthroat populations.

1. Within each geographic area, or major sub-basin occupied by pure populations representative core areas should be selected to provide long-term healthy habitats and strong populations. The highest priority areas for providing critical components in aquatic ecosystems would be either wilderness and roadless areas, followed by remote, limited activity areas so as not to compromise the pure population. Areas so designated would provide a cornerstone for maintaining the biological diversity of the sub-basin ecosystem. Such areas could be designated as genetic reserves or preserves and incorporated within Forest Plans as special interest areas (SIA's), i.e. Zoological, or research natural areas (RNA's).

2. Maintenance of pure populations, within sub-basins may require removal of non-native or exotic species which threaten or place at risk the continued existence of the cutthroat trout. This may be necessary within the sub-basins in which pure populations occupy

habitat and/or in adjacent, but interconnected sub-basins where metapopulation dispersal occurs. Agencies need to work together to eliminate non-native threats within the sub-basin where they are occurring or could occur, while still maintaining historic biodiversity.

3. Where pure populations occur outside their historic range care should be taken to protect and preserve the populations. Management emphasis and conservation strategies should apply equally to these sub-basin ecosystems as they would to pure populations within the Bonneville Basin.

4. Since few pure populations occur in stream-lake interchange environments, it would be beneficial to enhance certain sub-basin populations by introducing BCT into high-elevations historic occupied waters on national forests, particularly wilderness and roadless areas. Such extension of distribution could occur in the High Uinta Wilderness Area and Uinta Mountain Range. It could include introduction into historically fishless waters if necessary outside of wilderness area or into waters where non-native or exotic trout have been removed. This should only be done once it has been jointly determined by management agencies that such introduction would not place at risk or eliminate other indigenous aquatic communities and flora. It may further be necessary to protect these pure populations from upper watershed threats, if such exists at higher elevations, by removing non-native or exotic fish, or by discontinuing stockings and allowing lakes to revert to their historically fishless state.

C) RESTORATION

An important focus for agency emphasis is the restoration of BCT populations within their historic range. Because natural populations have collapsed throughout their range, we must identify methods that preserve the remaining genetic diversity, and at the same time increase the number of pure populations and expand their distribution within the Bonneville Basin.

1. Emphasis should be focused on restoration of genetically pure populations. Restoration of streams within the same sub-basin in which pure populations occur should be given priority. Genetically significant watersheds and sub-basins should be identified, since geographic isolation has resulted in significant genetic differences in populations within the subspecies' range. Pure populations should only be used within the same major sub-basin in which they occur, and re-introduced only into streams that have no exotic or introgressed populations. Management of and for supplemental gene flow must be practiced with caution so as not to lose unique genetic traits of individual populations within geographically separated or isolated sub-basins. If historical corridors for gene flow have been "recently" severed by anthropogenic factors, then the adverse effects of a loss of or reduction in genetic diversity in small, subdivided populations could be reduced or reversed by small scale introductions among previously contiguous populations. For example, restoration of Western Bonneville (WB) populations in the Snake Valley sub-basin should draw on existing WB population exchanges rather than mixing them with other similar, but geographically isolated populations (i.e. Northern Bonneville populations on the east side of the basin).

2. Priority watersheds, within sub-basins, should be established and managed as a unit to serve as networks of refugia. These watersheds should provide both excellent habitat and strong assemblages of indigenous species, as well as have a high restoration

potential. The watersheds should have established Riparian Habitat Conservation Areas (RHCA's) with specific riparian management objectives (RMO's) designed to modify, postpone, or cancel any "unacceptable risk" activities that may cause habitat to decline and populations to decrease such that the continued existence of the population within priority watersheds is at risk. For activities or groups of activities, which could include grazing, mining, timber harvest, roading, etc. which are considered to pose an unacceptable risk to the population, a preferred course of action should be identified and implemented, through NEPA and Forest Plan amendment, to ensure that they no longer pose unacceptable risk to subspecies restoration. In order for any naturalization of watersheds to occur, the cause must be treated, not just the symptom of the ecological disruption. Ecosystem assessments at the forest planning level should be completed at the watershed and sub-basin scales to enhance these management efforts.

3. State and federal agencies should cooperate, along with all their respective local publics and conservation group partners, in developing and implementing sub-species specific conservation strategies and agreements that provide for establishment of genetically pure BCT populations within sub-basins of their historic occurrence. Each sub-basin should be assigned a specific number of waters, viable population sizes, and habitat condition to assure adequate recovery within each major geographic area of occurrence, i.e. Western Bonneville population, Northern Bonneville, etc.

4. Restoration efforts should focus on multiple species management within aquatic ecosystems in sub-basins rather than single species management. Indigenous non-game fish, and other aquatic biota must be considered as they share the same stream systems. It should be a standard practice to also provide for these biota rather than placing them at risk, and pushing them towards federal listing status and possible extinction.

5. Metapopulation dynamics should be considered, where possible, to enhance protection of phenotypic and genetic diversity of populations as well as enhancing long term population viability. Conventional land-use management has compromised the metapopulation process and natural stream mosaic patterns and habitat conditions of historic BCT populations. The creation and maintenance of a more natural mosaic stream - habitat interchange within sub-basins should commence wherever possible. The naturalization of certain watersheds to resemble predisturbance conditions will increase populations chances for future survival.

6. States, through their management plans, should emphasize indigenous species restoration, both for scientific uses and recreational public purposes. The designation of both "conservation" and "management" populations within sub-basins would enhance scientific and biological integrity of BCT populations, while at same time allowing the public user to benefit from a unique resource specific to local cultural heritage.

SUMMARY

The recovery of the BCT within the Bonneville Basin must continue to focus on an integrated ecosystem approach within priority sub-basins and watersheds. State and federal agency cooperation and communication in BCT program emphasis must be stressed, as well as responsibility to and accountability for management activities and decision making. Accomplishment of this responsibility

will require the use of this assessment by line officers, and managers, to completely evaluate all programs so as not to jeopardize the continued existence of sub-basin specific BCT populations. Information herein will also be useful in biological evaluations (BE's) and biological assessments (BA's) to assess both habitat conditions and population status for activities and uses proposed on NFS lands that may impact and/or jeopardize, or restore BCT populations. Management policy governing resolution of conflicts occurring between conflicting land use activities should be emphasized to give preferential consideration to stream riparian dependent resources. Emphasis of protection and improvement of soil, water, and vegetation associated with BCT populations and recovery areas should be given so as to prevent further demise of existing BCT populations and habitats, or their eventual listing under the Endangered Species Act.

Management strategies, both internal and interagency, for amendment and revision to the Forest Plan process should immediately use this BCT assessment information to provide future coordinated management. This will accelerate recovery and the restoration of populations and the expansion of habitat on NFS lands and adjacent lands. Maintaining and enhancing BCT populations on NFS lands is key to restoration of the BCT within the Bonneville Basin, since range expansion will draw on these populations as brood sources for transplants into similar geographical habitats on other federal, state, etc. lands. Protecting and maintaining occupied NF habitat and expanding populations and habitat is the best strategy to preserve the ecological functions and natural processes characteristic of historic BCT populations. This is the agencys' best strategy to avoid extirpation of the BCT or any of its distinct population segments within the Bonneville Basin.

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TABLE 1 - Occurrence of existing Bonneville cutthroat trout (BCT) in sub-basins of the Bonneville Basin.

STATE	# Sub-Basins [1]	# Sub-Basins		
		Historic	Existing	Extinct
UTAH	30	26 *	14 (50%)	14 (50%)
NEVADA	5	4	1 (25%)	3 (75%)
WYOMING	2	2	1 (50%)	1 (50%)
IDAHO	6	6	4 (67%)	2 (33%)

[1] Totals include some shared sub-basins between states. Thirty total sub-basins occur within Bonneville Basin.
* Includes upper Virgin River sub-basin, a portion of which was historically part of Bonneville Basin

TABLE 2 - Bonneville Cutthroat Trout (BCT), historic and present occurance populations and status by hydrologic sub-basin.

Major Basin	Name/ # of Sub-basins ( )	BCT Area [1]	Historic Occurance [2]	Present Occurance [3]	# Populations [4]		Population Status [5]
					Stream	Lake	
Bear River	Upper Bear (2)	BRB	Yes - 2	P2	29 (6 BLM)	1 (1 Priv.)	ARS
Great Salt Lake	Lower Bear (4)	BRB	Yes - 4	P3	6	0 (1 State)	ARD
Great Salt Lake	Weber (2)	NB	Yes - 2	P1/E1	1	0	ARD
Great Salt Lake	Jordan (4)	NB	Yes - 4	P1/E3	2 (1 SLC)	1	ARD
Great Salt Lake	Great Salt Lake (West) (9)	WB	Yes - 7	P2/E5	2 (2 BLM)	0	ARD
Escalante Desert Sevier Lake	Escalante (9)	SB	Yes - 6	P4/E4	11	2	SST
Central Nevada [6]	Desert Basin (1)	WB	No	P1	2 (1 BLM)	0	ARD
Lower Colorado [7]	Upper Virgin (1)	SB	Yes - 1	P1	10	0	SEX

[1] Area distribution of BCT populations, BRB = Bear River Bonneville, NB = Northern Bonneville, WB = Western Bonneville, SB = Southern Bonneville
[2] Occurance yes or no, and number of sub-basins with occurance
[3] Present (P) or Extirpated (E) and number of basins with each occurance.
[4] Number of separate BLM or other populations are noted in parenthesis ( ).
[5] ARS = at risk, stable; ARD = at risk, declining; SS = secure, stable; SE = secure, expanding
[6] Transplanted populations, out of historic range
[7] Historic population based on conjecture of natural geological stream capture event 2,000 years B.P.

TABLE 3 - Occurrence of Bonneville cutthroat trout by historic sub-basins on National Forest system lands.

STATE	National Forest	# Sub-Basins		
		Historic Habitat	Existing	Extinct
NEVADA	Humboldt	1	1 *	0
WYOMING	Bridger-Teton	1	1	0
IDAHO	Caribou	6	4	2
	Sawtooth	1	0	1
UTAH	Wasatch-Cache	11	3	8
	Uinta	6	0	6
	Manti-LaSal	5	0	5
	Fishlake	6	2	4
	Dixie	4	3 *	1
	Sawtooth	1	0	1

* BCT populations exist in one sub-basin outside the Bonneville Basin on both the Humboldt and Dixie NF's.

TABLE 4 - Bonneville Cutthroat Trout Populations by Geographic Region within Bonneville Basin.

Population Name *	National Forest		Other Lands	
	Remnant	Transplant	Remnant	Transplant
WB - UT	0	0	2 (a)	0
WB - NV	1	3 (b)	0	1 (a)
NB - UT	2	2 (c)	1 (d)	0
BRB - UT	5	0	1 (e)	1 (f)
BRB - ID	9	0	0	0
BRB - WY	22 (g)	0	6 (a)	0
SB - UT	5 (h)	18 (i)	0	0

* WB = Western Bonneville; NB = Northern Bonneville; BRB = Bear River Bonneville; SB = Southern Bonneville.
(a) BLM land
(b) Includes two transplants in Spring Valley, outside Bonneville Basin
(c) Includes Red Butte Reservoir
(d) Located in Salt Lake County
(e) Laucustrine population in Bear Lake, UT - ID
(f) Deseret Ponds on Deseret Land and Livestock Co.
(g) Includes Lake Alice
(h) Includes Reservoir & Water Canyon considered to be remnant but outside Bonneville Basin
(i) Includes two reservoirs, Manning Meadow and Barney Reservoirs; and 8 transplants in Upper Virgin River sub-basin.

TABLE 5 - Location of Bonneville Cutthrout Trout (BCT) populations on National Forests in Bonneville Basin.

National Forest *	Population	
	Remnant [1]	Transplant
WB: Humboldt	1	3 (a)
WB: Sawtooth	Extinct	0
WB: Caribou	Extinct	0
WB: Wasatch-Cache	Extinct	0
WB: Uinta	Extinct	0
NB: Wasatch-Cache	2	2 (b)
NB: Uinta	Extinct	0
NB: Manti-LaSal	Extinct	0
BRB: Wasatch-Cache	5	0
BRB: Caribou	9	0
BRB: Bridger-Teton	22 (c)	0
SB: Fishlake	2	7 (d)
SB: Dixie	3	11 (e)
SB: Uinta	Extinct	0
SB: Manti-LaSal	Extinct	0

* Geographic names assigned to Bonneville cutthroat trout populations are shown by each National Forest, ie. WB = Western Bonneville, NB = Northern Bonneville, BRB = Bear River Bonneville, SB = Southern Bonneville.

[1] Sub-populations labeled "extinct" indicate no known BCT occurrence has been documented at this time.

(a) Includes two transplants in Spring Valley, outside Bonneville Basin
(b) Includes Red Butte Reservoir
(c) Includes Lake Alice
(d) Includes Manning Meadow and Barney Reservoirs
(e) Includes eight (8) transplants in Upper Virgin River sub-basin.

TABLE 6 - Distribution and demographic information for Western Bonneville (WB) Cutthroat Trout within Nevada & Utah.

Sub-basin	Associated National Forest	Historic Habitat [1]				National Forest Occupied Habitat				Population Status [2]
		Total		National Forest		Current Occupied Habitat		Percent of Total Historic	Percent of N.F. Historic Current	Population Status
		Stream (Miles)	Lake (#)	Stream (Miles)	%	Stream (Miles)	Lake (#)	Stream	%	
Snake Valley (NV) [3]	Humboldt	22	0	14	64	4.25	0	19	30	P:ARS
Spring Valley (NV) [4]	Humboldt	0	0	0	0	4.0	0	0	0	P:ARS
Steptoe Valley (NV) [5]	Humboldt	0	0	0	0	4.0	0	0	0	P:SST
Snake Valley [6]	Humboldt	277	0	70.5	25	4.25	0	1.5	6.0	P:ARS
No.GSL Desert	Sawtooth	42	0	10	45	0	0	0	0	E
Curlew Valley	Sawtooth	28	0	17.5	0	0	0	0	0	E

[1] Based on estimated stream miles perennial at time of European man explorations, circa 1800, pre-development era.
[2] P = present; E = extirpated; status is at-risk stable (ARS); secure stable (SST); at-risk declining (ARD); secure expanding (SEX)
[3] Includes two populations on Mt. Moriah division, Humboldt NF.
[4] Transplanted populations on two streams outside Bonneville Basin, on Mt. Wheeler, Humboldt NF.
[5] One transplanted population on Goshute Creek, Ely District, BLM outside Bonneville Basin.
[6] Summary of all Snake Valley historic habitat within Bonneville Basin, Nevada, and Utah, ie. sub-basins, 16020301 Hamlin-Snake Valley, and 16020306 Southern Great Salt Lake (GSL) (Snake Valley).

TABLE 6a - Distribution and demographic information for Western Bonneville (WB) Cutthroat Trout within Utah.

Sub-basin	Associated National Forest	Historic Habitat				National Forest Occupied Habitat				Population Status
		Total		Nadonal Forest		Current Occupied Habitat		Percent of Total Historic	Percent of N.F. Historic Current	Population Status
		Stream (Miles)	Lake (#)	Stream (Miles)	%	Stream (Miles)	Lake (#)	% Stream	% Stream	
Tooele Valley	Wasatch-Cache	17	0	9.5	56	0	0	0	0	E
Rush Valley	Uinta	35	0	23	66	0	0	0	0	E
Skull Valley	Wasatch-Cache	14	0	9.0	64	0	0	0	0	E
Sevier-Sheeprock	Uinta	14	0	6	43	0	0	0	0	E

TABLE 6b - Distribution and demographic information for Bear River Bonneville (BRB) Cutthroat Trout within Utah, Wyoming, and Idaho.

Sub-basin	Associated National Forest	Historic Habitat [2]				National Forest Occupied Habitat				Population Status [3]
		Total		National Forest		Current Occupied Habitat		Percent of Total Historic	Percent of N.F. Historic Current	Population Status
		Stream (Miles)	Lake (#)	Stream (Miles)	%	Stream (Miles)	Lake (#)	% Stream	% Stream	
Upper Bear, UT	Wasatch-Cache	352	2	70	20	13.5	0	3.8	1.9	P:ARS
Central Bear ID,WY	Caribou, Bridger-Teton	263	1	142	54	109	1	.41	77	P:ARS
Bear-Soda, ID	Caribou	277	0	86	26	13.5	0	4	16	P:ARD
Middle Bear, ID	Caribou	356	0	61	17	3.0	0	0.008	4.9	P:ARD
Malad-Bear, ID	Caribou	454	0	48	11	1.5	0	0.003	3	P:ARD
Logan-Bear	Wasatch-Cache	236	0	161	61	0	0	0	0	E

TABLE 6c - Distribution and demographic information for Northern Bonneville (NB) Cutthroat Trout within Utah.

Sub-basin	Associated National Forest	Historic Habitat				National Forest Occupied Habitat				Population Status
		Total		National Forest		Current Occupied Habitat		Percent of Total Historic	Percent of N.F. Historic Current	Population Status
		Stream (Miles)	Lake (#)	Stream (Miles)	%	Stream (Miles)	Lake (#)	% Stream	% Stream	
Weber River	Wasatch-Cache	576	0	207	36	4	0	0.006	1.9	P:ARD
Jordan River	Wasatch-Cache	139	0	37	27	3.5	1	2.5	9.4	P:ARS
Spanish Fork	Wasatch-Cache, Uinta	240	0	121	50	0	0	0	0	E
Provo, UT Lake	Wasatch-Cache, Uinta	223	1	86	39	0	0	0	0	E

TABLE 6d - Distribution and demographic information for Southern Bonneville (SB) Cutthroat Trout within Utah.

Sub-basin	Associated National Forest	Historic Habitat				National Forest Occupied Habitat				Population Status
		Total		National Forest		Current Occupied Habitat		Percent of Total Historic	Percent of N.F. Historic Current	Population Status
		Stream (Miles)	Lake (#)	Stream (Miles)	%	Stream (Miles)	Lake (#)	% Stream	% Stream	
Upper Sevier	Dixie	219	0	84	38	0.7	0	0.003	0.008	P:SEX
East Fk Sevier	Dixie	209	0	78	37	6.0	0	2.8	7.6	P:SST
Middle Sevier	Fishlake	416	0	177	43	4	2	0.009	2.2	P:SEX
San Pitch	Manti-LaSal, Uinta	207	0	45	22	0	0	0	0	E
Lower Sevier	Fishlake, Uinta	274	0	26	8	0	0	0	0	E
Beaver	Fishlake	216	0	57	26	10.7	0	4.9	19	P:SST
Upper Virgin *	Dixie	25	0	25	100	16.2	0	65	65	P:SEX

* Includes only estimated stream miles from Bonneville Basin "transferred" from a natural geologic stream capture event 2,000 year B.P.

TABLE 7 - Genetic Validation information for Bonneville cutthroat trout (BCT) available for sub-basins and populations in Nevada, Idaho, Wyoming and Utah on National Forests. Entries are numbers of populations.

State - BCT Region	# Sub-basins TOTAL	Current # Sub-basins OCCUPIED	# Stream Population	# Lake Population	Meristics	Electrophoresis	DNA
Nevada - Western BCT *	5	2	4	0	4	4	1
Utah - Western BCT ***	9	1	2	0	2	2	2
Wyoming - Bear River BCT	2	1	21	1	21	1	0
Idaho - Bear River BCT	6	5	9	0	8	0	0
Utah - Bear River BCT	6	1	5	0	4	4	2
Utah - Northern BCT	6	2	3	1	4	4	4
Utah - Southern BCT **	10	5	21	2	17	18	12

* Includes one sub-basin outside Bonneville Basin in Spring-Steptoe Valley, Nevada, #16060008 where BCT exists by introductions on Humboldt National Forest (2 populations) and BLM (1 population).
** Includes one sub-basin Upper Virgin River drainage where BCT exist by introductions, #15010608.
*** No populations known to occur on National Forests (Sawtooth, Caribou, Wasatch-Cache and Uinta); only sub-basin occupied is on BLM with two populations.

TABLE 8 - Origin, life history and well being of current Bonneville Cutthroat Trout (BCT) in occupied sub-basins in Idaho, Wyoming, Utah and Nevada. Tabular entries are numbers of populations.
REM = remnant, Trans = transplanted, UNK = Unknown, RES = resident, FLV = fluvial, ADF = adfluvial, ABD = abundant, Comm = common, EXT = extinct

State	# Sub-basins	Origin of Populations				Life History				Abundance			
		REM	Hatchery	Trans	UNK	RES	FLV	ADF	UNK	ABD	Comm	Rare	Ext
Idaho	4	9	-	-	-	9	-	-	-	-	9	-	-
Wyoming	2	22	-	-	-	18	2	2	-	-	22	-	-
Utah	14	12	-	20	-	32	-	-	-	9	14	9	-
Nevada	5	1	-	3	-	4	-	-	-	3	1	-	-

TABLE 9 - Presence of exotic fish species in Bonneville cutthroat trout (BCT) occupied sub-basins, including hatchery cutthroat from another geographic location. Entries are numbers of BCT populations.

State	# Sub-basins	Rainbow	Brook	Brown	Cutthroat	Other
Idaho	4	9		9	9	
Wyoming	2	22		18	21	
Utah	14	10	8	7	7	
Nevada	2	4			4	

TABLE 10 - Habitat condition status for 3 sub-basins supporting Western Bonneville (WB) Cutthroat Trout within Nevada and Utah. Condition and trend entries are numbers of populations.
Exc = excellent, ExD = extremely degraded, Inc = increases, Stab = stable, Dec = decreasing, Unk = unknown

	# of Sub-basins		Overall Condition					Trend			
	Total	Occupied	Exc	Good	Fair	Poor	ExD	Inc	Stab	Dec	Unk
Humboldt National Forest *	2	2		2	2				4		
Nevada Lands **	5	2		2	3				5		
Utah Lands ***	9	1		2					2		

* Includes one sub-basin outside Bonneville Basin in Spring-Steptoe Valley where WB introduced by Nevada.
** Includes BLM lands where one population of WB exists, all sub-basins are partially within Utah.
*** No National Forest Lands involved in occupied habitat; no known populations in Raft River Range, Sawtooth National Forest, and Stansbury - Sheeprock Range, Wasatch-Cache National Forest; includes all sub-basins in area known as Utah's West Desert, essentially lands west of the Great Salt Lake and south to Pine Valley sub-basin. Only two know populations occur here, both on BLM lands.

TABLE 11 - Factors affecting habitat quality of Western Bonneville (WB) Cutthroat Trout in Nevada and Utah in 2 occupied sub-basins. Factor and land-use activity entries are numbers of populations.
DW = dewater, Chem = chemical pollution, Temp = temperatures, CM = channel modification, LW = limited wood, Sed = sediment

	# of Sub-basins	Factors Affecting Habitat Condition						Land-use Activities Associated with Factors				
National Forets		DW	Chem	Temp	CM	LW	Sed	Grazing	Mining	Logging	Road Const	Agriculture
Humboldt	2	2			2		2	4	2		2	
All Nevada Lands *	2	3			2		3	3	2		2	
All Utah Lands **	1	2			2	2	1	2	2		2	1
All Lands [1]	5	5		5	5		5	5	3		5	4

* Includes one sub-basin outside Bonneville Basin in Spring-Steptoe Valley where BCT was introduced by Nevada.
** No National Forest lands involved.
[1] Includes five sub-basins shared by UT and NV, three of which have no known BCT populations.

TABLE 12 - Western Bonneville Cutthroat Trout (WB) population status - Based on information from 3 occupied sub-basins, Nevada and Utah. [1]

Population Status	# of Sub-basins/# Number of Populations	# of Sub-basins/ % by populations
Secure - expanding (HNF)	1/1	33/14
Secure - stable (HNF: BLM - NV)	1/2	33/29
At-Risk - stable (HNF)	1/2	33/29
At-Risk - declining (BLM-UT)	1/2	33/29
Unknown	8/0	-/-
Exotic species present	3/5	100/71
Exotic species viewed a threat	3/7	100/100
Extinct [2]	9 (extinct in 7)	78% extinct

[1] Includes one sub-basin outside Bonneville Basin in String-Steptoe Valley where WB introduced by Nevada; includes four populations on Humboldt N.F., NV (HNF), one on BLM, NV, and two on BLM, UT lands.
[2] Includes nine sub-basins defined as WB historic habitat from Raft River Mountain-Curlew area on north to closed-basins west and south of Great Salt Lake to Pine Valley sub-basin. Does not include the one Nevada sub-basin outside the Bonneville Basin with transplanted WB.

TABLE 13 - Habitat condition status for sub-basins supporting Bonneville Cutthroat Trout (BCT) within Utah. Condition and trend entries are numbers of populations.
Exc = excellent, ExD = extremely degraded, Inc = increases, Stab = stable, Dec = decreasing, Unk = unknown.

	# of Sub-basins		Overall Condition					Trend			
	Total	Occupied	Exc	Good	Fair	Poor	ExD	Inc	Stab	Dec	Unk
National Forests [1]	18	8	9	10	2	5	1	13	9	5	10
Wasatch-Cache (NB)	10	2	-	3	1	-	-	2	2	-	-
Wasatch-Cache (BRB)	1	1	-	-	-	5	-	-	-	5	-
Fishlake (SB) *	6	2	-	8	3	-	-	4	3	-	2
Dixie (SB) **	4	3	9	1	2	1	1	8	3	-	3
Other Lands	27	14	-	-	-	1	8	-	10	1	3

[1] Geographic names assigned to Bonneville cutthroat trout populations are shown with each National Forest, ie. NB = Northern Bonneville, BRB = Bear River Bonneville, SB = Southern Bonneville
* Two sub-basins are shared by both Fishlake and Dixie National Forests.
** One sub-basin, the Upper Virgin, is outside the Bonneville Basin, but has eight transplanted populations.

TABLE 14 - Bonneville Cutthroat Trout (BCT) population status - Based on information from 8 occupied sub-basins, for 32 know populations on National Forests in Utah [1].

Population Status	# of Sub-basins/# Number of Populations	# of Sub-basins/ Percentage by populations
Secure - expanding	6/16	75/56
Secure - stable	4/6	50/19
At-Risk - stable	4/7	50/22
At-Risk - declining	1/1	13/3
Unknown	0/0	0/0
Exotic species present	8/19	100/59
Exotic species viewed a threat	8/11	100/34
Extinct	28 historic / 14 extinct	50% extinct

[1] Includes one sub-basin the Upper Virgin River outside Bonneville Basin, portions of which are considered historic due to possible natural volcanic stream capture event.

TABLE 15 - Factors affecting habitat quality of Bonneville Cutthroat Trout (BCT) in Utah. Tabular entries are numbers of populations.
DW = dewater, Chem = chemical pollution, Temp = temperatures, CM = channel modification, LW = limited wood, Sed = sediment.

	# of Sub-basins		Factors Affecting Habitat Condition						Land-use Activities Associated with Factors				
	Total	Occupied	DW	Chem	Temp	CM	LW	Sed	Grazing	Mining	Logging	Road Const	Agriculture
National Forests [1]	18	8	8	3	5	8	5	12	8	0	3	6	0
Wasatch-Cache (NB)	10	2	1	0	0	1	1	1	1	0	0	0	0
Wasatch-Cache (BRB)	1	1	3	3	5	3	3	5	5	0	2	4	0
Fishlake *	6	2	0	0	0	3	1	1	2	0	1	0	0
Dixie **	4	3	4	0	0	1	0	5	2	0	0	2	0
Other Lands	27	14	13	5	6	10	14	14	10	0	0	5	0

[1] Geographic names assigned to Bonneville cutthroat throut populations are shown with each National Forest, ie. NB = Northern Bonnveville, BRB = Bear River Bonneville, SB = Southern Bonneville
* Two sub-basins are shared by both Fishlake and Dixie National Forests.
** One sub-basin, the Upper Virgin, is outside the Bonneville Basin, but has eight transplanted populations.

TABLE 16 - Wyoming Bear River Bonneville Cutthroat Trout (BRB) population status - Based on information from 2 sub-basins and 22 populations.

Population Status	# of Sub-basins / # of Populations	# of Sub-basins / Percentage by Populations
Secure - expanding	2/1	100/5
Secure - stable	2/21	100/95
At-Risk - stable	-	-
At-Risk - declining	-	-
Unknown	-	-
Exotic species present	2/22	100/100
Exotic species viewed a threat	2/22	100/100

TABLE 17 - Habitat condition status for sub-basins supporting Bear River Bonneville Cutthroat Trout (BRB) within Wyoming. Tabular entries are numbers of populations.
Exc = excellent, ExD = extremely degraded, Inc = increases, Stab = stable, Dec = decreasing, Unk = unknown

		Overall Condition					Trend			
National Forests	# of Sub-basins	Exc	Good	Fair	Poor	ExD	Inc	Stab	Dec	Unk
Bridger-Teton*	2		21	1				22		
Other Lands**	2			4	4			2	6	

* Includes 3 stream populations shared with Caribou National Forest, Idaho.
** Includes BLM and private.

TABLE 18 - Factors effecting habitat quality of Bear River Bonneville Cutthroat Trout (BRB) in Wyoming. Tabular entries are numbers of populations.
DW = dewater, Chem = chemical pollution, Temp = temperatures, CM = channel modification, LW = limited wood, Sed = sediment

		Factors Affecting Habitat Condition						Land-use Activities Associated with Factors				
National Forests	# of Sub-basins	DW	Chem	Temp	CM	LW	Sed	Grazing	Mining	Logging	Road Const	Agriculture
Bridger-Teton*	2	3	-	1	3	3	22	20	-	-	15	-
Other Lands**	2	7	1	5	7	7	7	7	-	-	7	2

* Includes 3 stream populations shared with Caribou National Forest, Idaho.
** Includes BLM and private.

TABLE 19 - Idaho Bear River Bonneville Cutthroat Trout (BRB) population status - Based on information from 4 occupied sub-basins and 9 populations.

Population Status	Number of Sub-basins / Number of Populations	Percentage by Sub-basins/Populations
Secure - expanding	0/0	0/0
Secure - stable	0/0	0/0
At Risk - stable	2/4	50/44
At Risk - declining	1/3	25/33
Unknown	2/2	50/22
Exotic species present	4/9	100/100
Exotic species viewed a threat	4/9	100/100

TABLE 20 - Habitat condition status for sub-basins supporting Bear River Bonneville Cutthroat Trout (BRB) within Idaho. Condition and trend entries are numbers of populations. Exc = excellent, ExD = extremely degraded, Inc = increases, Stab = stable, Dec = decreasing, Unk = unknown.

		Overall Condition					Trend			
National Forests	Sub-basins	Exc	Good	Fair	Poor	ExD	Inc	Stab	Dec	Unk
Caribou *	4			7	2			4		5
Sawtooth **	1	-	-	-	-	-	-	-	-	-
Other Lands	5					5				5

* One sub-basin is shared by both Caribou and Sawtooth National Forests, and one sub-basin shared by both Caribou and Bridger-Teton National Forest.
** The Sawtooth National Forest has no known BCT populations present. All Idaho sub-basins are partially shared with Utah.

TABLE 21 - Factors affecting habitat quality of Bear River Bonneville Cutthroat Trout (BRB) in Idaho. Tabular entries are numbers of populations. DW = dewater, Chem = chemical pollution, Temp = temperatures, CM = channel modification, LW = limited wood, Sed = sediment.

	Sub-basins	Factors Affecting Habitat Condition						Land-use Activities Associated with Factors				
National Forests		DW	Chem	Temp	CM	LW	Sed	Grazing	Mining	Logging	Road Const	Agriculture
Caribou	4			7	6	5	9	7				
Other Lands	5	5	5	5	5	5	5	5				5

Chapter 4

Rio Grande Cutthroat Trout
Oncorhynchus clarki viriginalis

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INTRODUCTION

The Rio Grande cutthroat trout, *Oncorhynchus clarki virginalis*, is one of two salmonids native to New Mexico, and one of three salmonids native to Colorado. The Rio Grande cutthroat trout is a popular game fish. Information concerning the status of Rio Grande cutthroat trout was obtained through a survey of biologists from the Forest Service, Bureau of Land Management, New Mexico Game and Fish, and Colorado Division of Wildlife in the States of Colorado and New Mexico. A mixture of habitat and population data are available for most of the known populations. However, the data are lacking overall for qualitative and quantitative analysis of the status of Rio Grande cutthroat trout. The data were taken from survey forms in accordance with direction from Region 4, USDA Forest Service, Ogden, Utah. In most cases, the data represent the best professional judgement of biologists that was based on specific experiences with individual streams and populations.

STATUS, DISTRIBUTION, AND RANGE

For purposes of this assessment, cutthroat trout populations were defined on the basis of DNA analysis of specific populations and suspected reproductive isolation based on meristics identification. Genetic data for differentiation are available for many populations and indicate reproductive isolation among major watersheds. Even in the absence of genetic information, populations may initially be delineated in areas where they have become isolated and fragmented or separated by migration barriers.

Historic Distribution

The historic range of the Rio Grande cutthroat is not definitely known although it likely encompassed all waters presently capable of supporting trout in the Rio Grande drainage, including the Chama, Jemez, and Rio San Jose drainages along with "trout" waters of the Pecos and Canadian drainages (Figure 1). This distribution

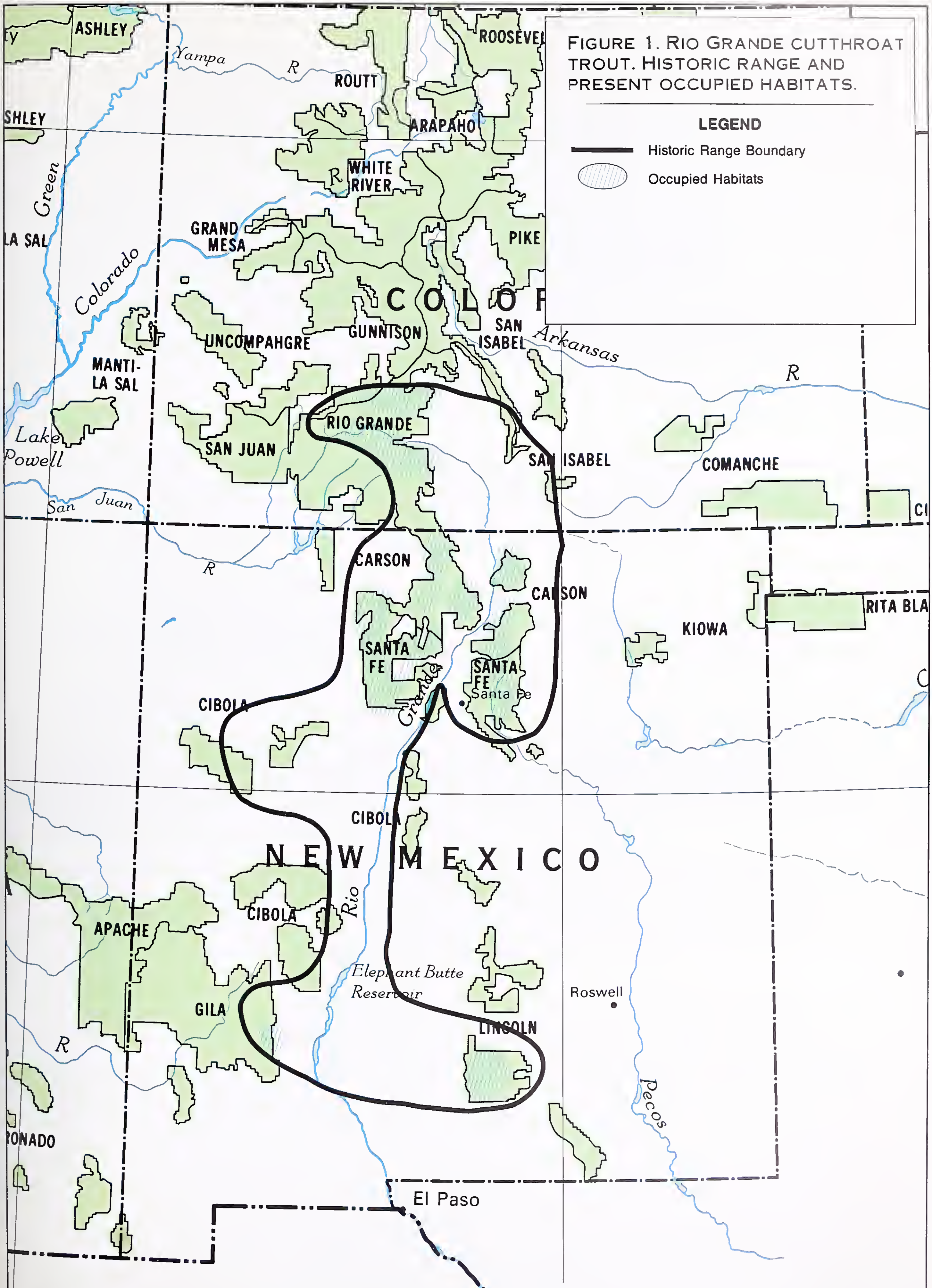

FIGURE 1. RIO GRANDE CUTTHROAT TROUT. HISTORIC RANGE AND PRESENT OCCUPIED HABITATS.
LEGEND
Historic Range Boundary
Occupied Habitats
ASHLEY
ROOSEVELT
ROUTT
ARAPAHO
WHITE RIVER
GRAND MESA
PIKE
COLORADO
GUNNISON
SAN ISABEL
UNCOMPAHGRE
MANTI-LA SAL
RIO GRANDE
SAN JUAN
SAN ISABEL
COMANCHE
CARSON
CARSON
KIOWA
RITA BLANCA
SANTA FE
SANTA FE
Santa Fe
CIBOLA
CIBOLA
NEW MEXICO
APACHE
CIBOLA
GILA
Elephant Butte Reservoir
Roswell
LINCOLN
El Paso
Yampa R
Green
Colorado
Lake Powell
San Juan R
Arkansas R
Rio Grande
Pecos

could have covered approximately 40 hydrologic sub-basins in Colorado and New Mexico, and potentially as far south as Mexico (Table 1).

Present Distribution

In Colorado, 39 populations have been identified, 21 on public land (mostly Forest Service) and 18 on private land. Most of the populations are found in the headwaters of streams, and are isolated.

In New Mexico, 53 populations have been identified, 46 on public land and 7 on private land. The distribution of Rio Grande cutthroat trout has declined to 9 percent of its former range in New Mexico and is confined primarily to small, high mountain head-water streams mostly within Forest Service jurisdictional lands (Table 9).

Trend

Of the 92 populations identified, 4 populations are classified as secure and increasing and 29 populations are thought to be secure and/or stable (Table 2 &3). Stable indicates that the population is not increasing or decreasing. Eight of the populations are thought to be declining. The status of 51 of the populations is unknown. Sixty nine of the populations are considered remnants (Table 6).

IMPLICATIONS OF MANAGEMENT

Most Forest Plans will undergo revision during the next several years. Standards and guidelines for the protection, restoration, and enhancement of Rio Grande cutthroat trout will be a part of each Forest Plan.

Summary of Threats

Management activities, primarily grazing of domestic livestock and diversion of water for irrigation purposes, are the major factors adversely affecting currently occupied and historical cutthroat trout habitat. Table 5 summarizes that dewatering and sedimentation are the two most prevalent factors affecting habitat conditions and that grazing and road construction are the two most common land-use activities associated with these factors.

Habitat loss is among the critical factors causing the decline of cutthroat trout, therefore habitat restoration is essential to reestablishing cutthroat trout to their former ranges. Overall condition of the watersheds (Table 4) indicates that most are either in a good or fair condition and that the trend for most are stable (38%) or unknown (55%). Habitat parameters such as overhanging banks, riparian vegetation, in stream boulders, log jams, pools, water volume and water depth need to be restored. Watershed conditions need to be improved.

Other than adverse impacts on physical habitat, the principal threat to cutthroat trout populations is interaction with non-native species of fish, primarily other trout (Table 8). Hybridization and competition with non-native fish can lead to the eventual displacement of native cutthroat trout. Habitat disruption may also favor introduced species at the expense of native species. By constructing fish migration barriers, non-native fish can be prevented from immigrating from adjacent stream sections. Also, hatchery stocking of non-native fish should be curtailed, and stocking of Rio Grande cutthroat trout should originate from similar wild populations of Rio Grande cutthroat trout.

Protection

The Rio Grande cutthroat trout evolved in areas where it was the only trout species present. As people started to populate the area, these fish were then exposed to overharvest. In response to the fish s decline, pressure was put on the Game and Fish to stock fish. Since the late 1800's there has been introduced trout stocked throughout most of the Rio Grande cutthroat native range. Problems resulted in that the Rio Grande cutthroat will readily hybridize (introgress) with other spring spawning trout such as rainbow trout (*Oncorhynchus mykiss*), and other subspecies of *O. clarki*. Further more, these non-native (exotic) salmonids, together with introduced fall spawners (brook trout, *Salvelinus fontinalis* and brown trout, *S. trutta*) compete with Rio Grande cutthroat for food and space. To insure survival of the Rio Grande cutthroat trout, it is imperative that exotic salmonids are excluded from the streams where *O. c. virginalis* persist (Sublette, 1990).

The only protection from non-native salmonids for most Rio Grande cutthroat trout populations comes in the form of some physical barrier that stopped the upward migration of other introduced trout. Most common types of barriers are natural waterfalls made out of rock or woody materials and beaver dams. As woody materials age and beaver dams are abandoned and silted in, many get washed out. Identifying, enhancing, or building barriers to the upstream migration of nonnative trout to protect populations of Rio Grande cutthroat trout is of prime importance.

Since all subspecies of cutthroat trout seem to be extremely vulnerable to angling, special fishing regulations to protect populations of Rio Grande cutthroat trout are needed. The regulations may include variations of angling methods, size, bag limit, and season. Strict enforcement of regulations will be required.

Enhancement

Although there are many gaps in the knowledge of Rio Grande cutthroat trout, current knowledge of habitat needs and influence of hybridization with other trouts is sufficient for management agencies to increase management efforts to reverse the decline of Rio Grande cutthroat trout. Research and management should immediately coordinate efforts to increase Rio Grande cutthroat trout populations throughout its historical range.

Of primary importance to management should be the identification of existing populations through genetic analysis; the survey of habitat quality for each population; identification and need for migration barriers; establishment of a priority list for the building of barriers to protect existing and proposed populations of cutthroat; and the establishment of hatchery sources of cutthroat trout to extend the range of the Rio Grande cutthroat trout.

Genetic analysis should be conducted to supplement previous meristic work. Although one individual method is not 100% accurate in detecting hybridization and to what extent, a combination of methods (Meristic, mDNA, Electrophoretic, Nuclear DNA) allows a better chance in making an accurate assessment of a fish populations purity. This information is critical to making sound management decisions on how individual waters are managed. Genetic analysis of wild populations will direct decisions regarding future transplants from wild stock.

Existing populations of Rio Grande cutthroat trout should be afforded protection from degradation of their habitat and land use practices should be tailored so as to improve habitat. Areas of known degradation should be targeted to correct habitat problems.

The establishment of a brood stock greatly enhances the possibilities of enhancing Rio Grande cutthroat trout through out its range. Waters previously stocked with non-native trout can then be stocked with native trout. The Colorado Division of Wildlife currently has a brood stock which allow them to stock Rio Grande cutthroat

trout into many of their wilderness lakes. The New Mexico Department of Game and Fish is currently in the process of developing a brood stock for their Rio Grande cutthroat trout program.

Restoration

Riparian habitats have been impacted by past land use activities. Most current management plans take into consideration riparian areas and limit the impacts of various activities. Some monitoring sites are established through enclosures, which will guide amounts of use different areas can tolerate. The whole watershed should be considered when improving the habitat for Rio Grande cutthroat trout.

Considerable work has been done to identify existing populations of Rio Grande cutthroat trout and their genetic purity. From this work, management has identified locations for the restoration of waters with Rio Grande cutthroat trout and for sources of pure strain Rio Grande cutthroat trout for transplants. Past, present, and future restorations rely on the use of piscicides (Rotenone and Fintrol) to ensure the complete removal of the non-native trout. There have been 16 waters restored to date. Restoration should provide for protection of other native aquatic species occupying treated waters.

Restoration efforts can be greatly enhanced by having a ready supply of Rio Grande cutthroat trout, supplied by hatcheries from brood stock, ready to go into reclaimed waters. The New Mexico Department of Game and fish contacted a population geneticist to develop a protocol in the development of a brood stock of pure Rio Grande cutthroat that would increase the overall heterogeneity of the stock, minimize inbreeding, and maintain as much of their wild characteristics as possible.

Also, some waters with Rio Grande cutthroat trout and non-native trout have been targeted for selective removal of non-native trout through electrofishing. These waters are usually small streams with fairly low amounts of vegetative cover and woody debris.

CONCLUSION

The current distribution and range of the Rio Grande cutthroat trout are about 10% of potential. This figure is of stream miles and lake acres. When put in context of area this percentage is even smaller due to the fact that most of these fish are relegated to isolated, small headwaters streams.

Overall, the status of the Rio Grande cutthroat can be summed up in that most populations are at risk and that there is a large number of populations where their status is unknown. Most populations were considered to be at risk because of presence of non-native (exotic) species. All populations are resident, and their overall abundance is considered to be common to rare. Most known populations have had some type of genetic analysis done on them (Table 7). Meristics has been completed on 87% of the populations, and electrophoresis has been completed on 42% of the populations.

Habitat conditions of watersheds where Rio Grande cutthroat trout occur can be summarized in that most are in good to fair condition, which is probably due to their high mountain headwater status. The trend for the habitat conditions is mostly stable of the ones known, but 55% of the habitats are of unknown condition. The major factors affecting habitat quality of Rio Grande cutthroat trout are excessive stream sediments, channel modifications, dewatering, and temperature. The most common land use activities associated with these factors were grazing, road construction and logging.

Future work will include monitoring, enhancing habitats, building barriers, and determining purity of existing populations. Introductions into new or restored habitats will continue. Establishment and expansion of brood stock will continue. New efforts will include creating a metapopulation of the native fish assemblage of Rio Grande cutthroat, Rio Grande chub (*Gila pandora*) and Rio Grande sucker (*Catostomus plebeius*).

Public agencies, utilities, irrigation districts, industry, private landowners, and conservation and sporting groups should be alerted for the presence of and the protection needs for Rio Grande cutthroat trout in their jurisdictions. It will be the responsibility of all to protect the habitats and populations of the cutthroat trout. Since Rio Grande cutthroat trout are found across state borders, participation and coordination among other state and federal agencies are imperative.

An information and education program should be designed to gain support for protection of and efforts to manage cutthroat trout. The information programs should be tailored to the different audiences: academia, agencies, conservation and nature groups, school children, special interest groups, sports people, and general public.

TABLE 1. Distribution and demographic information for Rio Grande cutthroat trout in Colorado and New Mexico. Population status - SE = secure expanding, SS = secure stable, ARS = at risk stable, ARD = at risk declining UNK = unknown.

Sub-Basin Name	USGS Hydro.Unit #	# Streams	# Lakes	National Forest	*Historic Occurance	Present Occurance	Population Status
COLORADO							
Rio Grande Headwaters	13010001	2	0	Rio Grande	Y	Y	ARS
Alamosa- Trinchea	13010002	4	1	Rio Grande	Y	Y	SS
Rio Grande Headwaters	13010003	2	1	Rio Grande	Y	Y	ARS
Rio Grande Headwaters	13010004	6	0	Rio Grande	Y	Y	ARS
Conejos	13010005	4	0	Rio Grande	Y	Y	ARS
Rio Chama	13020102	1	0	Rio Grande	Y	Y	ARS
Upper Rio Grande	13020101	0	0	Rio Grande	Y	N	E
Upper Canadian	11080001	0	0	Rio Grande	Y	N	E
NEW MEXICO							
Upper Canadian	11080001	1	0	Carson	Y	Y	ARD
Cimarron	11080002	1	0	Carson	Y	Y	ARD
Mora	11080004	3	0	Carson	Y	Y	ARD
Conejos	13010005	4	0	Carson	Y	Y	ARS
Upper Rio Grande	13020101	24	0	Carson	Y	Y	ARS

*Potential historic areas of occurance within the past 600 years.

Table 1 (Con't). Distribution and demographic information for Rio Grande cutthroat trout in Colorado and New Mexico.

Rio Chama	13020102	9	1	Carson/Santa Fe	Y	Y	ARS
Sub-Basin Name	USGS Hydro.Unit #	# Streams	# Lakes	National Forest	*Historic Occurance	Present Occurance	Population Status
Jemez	13020202	3	0	Santa Fe	Y	Y	ARS
Rio Puerco	13020204	3	0	Santa Fe/Cibola	Y	Y	ARS
Pecos Headwaters	13060001	9	0	Santa Fe	Y	Y	ARS
Rio Grande - Caballo	13030101	1	0	Gila	Y	Y	ARS
Tularosa Valley	13050003	1	0	Lincoln	Y	Y	UNK.
Rio Grande - Albuquerque	13020203	0	0	Cibola	Y	N	E
Arroyo Chico	13020205	0	0	Cibola	Y	N	E
Rio San Jose	13020207	0	0	Cibola	Y	N	E
Rio Salado	13020209	0	0	Cibola	Y	N	E
Rio Grande - Elephant Butte	13020211	0	0	NA	Y	N	E
El Paso - Las Cruces	13030102	0	0	Gila	Y	N	E
Jornada Draw	13030103	0	0	NA	Y	N	E
Rio Grande - West Estancia	13050001	0	0	Cibola	Y	N	E

*Potential historic areas of occurance within the past 600 years

Table 1 (Con't). Distribution and demographic information for Rio Grande cutthroat trout in Colorado and New Mexico.

Rio Grande - Sacramento River	13050004	0	0	Lincoln	Y	N	E
Upper Pecos	13060003	0	0	NA	Y	N	E
Alamosa Creek	13060004	0	0	NA	Y	N	E
Sub-Basin Name	USGS Hydro.Unit #	# Streams	# Lakes	National Forest	*Historic Occurance	Present Occurance	Population Status
Sub-Basin Name	USGS Hydro.Unit #	# Streams	# Lakes	National Forest	*Historic Occurance	Present Occurance	Population Status
Pecos - Artesia	13060007	0	0	NA	Y	N	E
Rio Hondo	13060008	0	0	Lincoln	Y	N	E
Pecos - Rio Felix	13060009	0	0	NA	Y	N	E
Rio Penasco	13060010	0	0	Lincoln	Y	N	E
Upper Pecos - Black River	13060011	0	0	Lincoln	Y	N	E
Ocate	11080003	0	0	Carson	Y	N	E
Conchas	11080005	0	0	NA	Y	N	E
Tucumcari	11080006	0	0	NA	Y	N	E
Ute	11080007	0	0	NA	Y	N	E
Plaza Largo	11080008	0	0	NA	Y	N	E

*Potential historic areas of occurance within the past 600 years.

Table 2. Colorado Rio Grande Cutthroat Trout population status- Based on information from 8 sub-basins.*

Status	#sub-Basins/ #of populations	Percentage by #sub-basins/ # of populations
Secure - expanding	3/4	38/19
Secure- stable	3/5	38/24
At Risk- Stable	1/4	13/19
At Risk- declining	3/5	38/24
Unknown	3/4	38/19
Exotic species present	8/13	100/62
Exotic species viewed a threat	8/10	100/48

* 3 sub-basins in Upper Rio Grande basin are entirely within Colorado, 5 sub-basins are shared with New Mexico.

Table 3. New Mexico Rio Grande Cutthroat Trout populations status- Based on information from 11 sub-basins and 54 populations.*

Status	Number of Waters	Percentage
Secure-expanding	0/0	0/0
Secure- stable	4/6	36/11
At Risk- Stable	7/16	64/30
At Risk- declining	3/9	27/17
Unknown	6/19	54/35
Exotic species present	10/44	91/82
Exotic species viewed a threat	10/33	91/61

*8 sub-basins are occupied within New Mexico and 5 sub-basins are shared with Colorado.

Table 4. Habitat condition status for watersheds supporting Rio Grande Cutthoat Trout in Colorado and New Mexico. Condition and trend entries are percentages. Exc = excellent, ExD = extremely degraded, Inc = increases, Stab = stable, Dec = decreasing, Unk = unknown

	Number of sub-basins		Overall Condition					Trend			
National Forests	Total	Occupied	Excellent	Good	Fair	Poor	ExD	Inc	Stab	Dec	Unk
Rio Grande	8	6	0	55/12	41/9	4/1	0	9/2	36/8	19/4	36/8
Carson*	7	5	4/1	46/12	46/12	4/1	0	0	12/3	0	88/23
Santa Fe*	7	6	15/4	39/10	46/12	0	0	4/1	27/7	4/1	65/17
Gila	2	1	0	100/1	0	0	0	0	100/1	0	0
Other Lands	7	7	0	50/4	13/1	37/3	0	0	13/1	0	87/7

*Carson and Santa Fe National Forests share sub-basin boundaries with each other or Coloardo.

Table 5. Factors affecting habitat quality of Rio Grande Cutthroat Trout in Colorado and New Mexico. Tabular entries are numbers of populations. DW = dewater, Chem = chemical pollution, Temp = temperature, CM = channel modification, LW = limited wood, Sed = sediment

	Sub-Basins	Factors Affecting Habitat Condition						Land- use Activities Associated with Factors				
National Forests		DW	Chem	Temp	CM	LW	Sed	Grazing	Mining	Logging	Road Const	Agriculture
Rio Grande	8	4	0	0	2	5	11	13	1	1	7	0
Carson	7	1	1	8	7	6	18	11	1	8	13	0
Santa Fe	7	3	0	0	9	1	7	13	0	0	1	0
Gila	2	0	0	1	0	0	0	1	0	0	0	0
Other Lands	7	8	0	1	13	4	16	10	0	0	1	0

Table 6. Origin, life history and well being of current Rio Grande Cutthroat Trout in Colorado and New Mexico. REM = reminent, Trans = transplant, UNK = unknown, RES = resident, FLV = fluvial, ADF = adfluvial, ABD = abundent, Comm = common, EXT = extinct

State	# Sub-Basins	Origin of Populations				Life History				Abundance			
		REM	Hatchery	Trans	UNK	RES	FLV	ADF	UNK	ABD	Comm	Rare	EXT
Colorado	8	7	0	14	0	21	0	0	0	4	13	4	0
New Mexico	12	46	0	4	2	52	0	0	0	6	23	22	1

Table 7. Genetic Validation Information available from the populations in Colorado and New Mexico.

National Forest	# Sub-Basins TOTAL	Current # Sub-Basins OCCUPIED	# Stream Populations	# Lake Populations	Meristics	Electro-phoresis	mtDNA
Rio Grande	8	6	33	6	39	0	0
Carson	7	5	29	0	25	20	5
Santa Fe	7	6	29	0	21	20	1
Gila	1	1	1	0	1	1	0
State Land	1	1	1	1	0	0	0
Private	2	1	1	0	1	2	0
Indian	2	2	2	0	2	0	0

Table 8 Presence of exotic fish species in Colorado and New Mexico that occure in waters with Rio Grande cutthroat trout. Entries are numbers of Rio Grande cutthroat trout populations occuring.

State/NF	#Sub-basins	# of Populations	Rainbow	Brook	Brown	Cutthroat
Colorado/ Rio Grande	8	21	4	8	2	0
New Mexico/ Carson	4	29	11	2	16	1
New Mexico/ Santa Fe	5	29	11	1	15	0
New Mexico/ Gila	1	1	1	0	0	0

Table 9. Current distribution of Rio Grande cutthroat trout in New Mexico vs. Total habitat available on public lands.

LAND STATUS	NUMBER OF SUB-BASINS	TOTAL		OCCUPIED		PERCENT OF TOTAL	
		STREAM MILES	LAKE ACRES	STREAM MILES	LAKE ACRES	STREAM	LAKES
BLM	11	247	5000	0	0	0	0
FOREST SERVICE							
Carson*	7	576	81	126	0	21.80	0
Gila	1	330	70	3	0	0.01	0
Lincoln	0	90	740	0	0	0	0
Santa Fe*	6	1100	429	83	0	7.50	0
Total	**11**	**2343**	**6320**	**212**	**0**	**9.10**	**0**

*Sub-basins are shared between the two National Forests

Editor's Note: This chapter will also be published in its entirety as a General Technical Report by the Rocky Mountain Station. In order to expedite publishing of our report and to accommodate these authors, we accepted their format for this chapter.

Chapter 5

Colorado River Cutthroat Trout
Oncorhynchus clarki pleuriticus

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ABSTRACT

Though biologists recognize that populations of Colorado River cutthroat trout have declined, the magnitude of the loss remains unquantified. We obtained information from state and federal biologists and from state databases to determine the current distribution and status of populations of Colorado River cutthroat trout. Recent population extinctions have been documented throughout this range. Hybridization with rainbow trout, nonindigenous cutthroat trout (those established or supplemented by stocking of genetically pure fish), and introgressed hatchery stocks has degraded many populations of Colorado River cutthroat trout. Only 26% of the remaining populations are believed to be genetically pure. Almost 45% of the remaining populations are at least partly sympatric with non-native trout species or hybridized hatchery stocks. Brook trout are the most common sympatric non-native species. Barriers (permanent, physical obstructions) to upstream migration are know to protect 27% of the indigenous populations from non-native stocks. Land management problems were inconsistently mentioned, but grazing and dewatering were the most frequently cited. As a consequence of these threats, the continued existence of Colorado River cutthroat trout is in doubt. Of the 318 waters, only 20 contain Colorado River cutthroat trout that are believed to be indigenous, genetically pure, allopatric above a barrier, and in a drainage not recently stocked.

INTRODUCTION

Many populations of Colorado River cutthroat trout have been exterminated since the late 1800s. The now-familiar causes, which include introductions of non-native fishes, habitat degradation, loss and fragmentation, and overharvest, were widespread throughout the historic range of this subspecies (Young 1995b). Most of these practices continue (Young 1995a) and presumably so does the loss of populations. An increased awareness of this loss has led to attempts to maintain and restore populations of this subspecies (e.g., Pister 1990) and to document their occurrence. Most assessments of the status and distribution of this subspecies have focused on portions of states or national forests (Remmick 1982; Oberholtzer 1987; Martinez 1988; Langlois et al. 1994), but a comprehensive overview of the security of the subspecies is lacking. The intent of this review was to: (1) examine historical information on the distribution of Colorado River cutthroat trout; (2) determine the current distribution of the subspecies in its former range of Wyoming, Colorado, and Utah (neglecting potential populations in Arizona and New Mexico); and (3) identify characteristics that could influence the persistence of these populations.

HISTORICAL DISTRIBUTION AND CURRENT MANAGEMENT

Comprehensive descriptions of the historical range of Colorado River cutthroat trout are unavailable. Behnke (1992) considered the range to include all accessible cool waters of the upper Colorado River drainage, including the Green, Yampa, Gunnison, Dolores, San Juan, Duchesne, and Dirty Devil rivers. By the 1970s, this distribution had been drastically reduced (Behnke and Benson 1980). The decline triggered responses from several management agencies. Colorado River cutthroat trout were classified as a Category 2 species (considered for formal listing under the Endangered Species Act until this category was abolished) by the U.S. Fish and Wildlife Service, a sensitive species by Regions 2 and 4 of the U.S. Forest Service, and designated with special status by Colorado, Utah, and Wyoming (Johnson 1987). Separate management plans for this subspecies have been prepared for northwestern Colorado, southwestern Colorado, south-central Wyoming, southwestern Wyoming, and Utah.

Conservation strategies have centered on surveys, angling restrictions, and channel modifications. Initially, population inventories were limited. Behnke and Zarn (1976) knew of only two genetically pure populations, both in Wyoming. However, they reported but did not identify a number of hybridized populations. Later surveys were more thorough and additional populations were located. Binns (1977) identified 42 waters in the Little Snake River, Blacks Fork, and upper Green River drainage in Wyoming that supported populations of this subspecies. Oberholtzer (1987) collected Colorado River cutthroat trout from 36 streams in the Little Snake River drainage. In the most extensive survey, Martinez (1988) evaluated 160 streams and lakes in northwestern Colorado within the historical range of this subspecies and found 96 populations of Colorado River cutthroat trout; 21 of which were considered genetically pure. Other intensive surveys of the distribution of this subspecies were completed in southcentral Wyoming (Oberholtzer 1990), southwestern Wyoming (Remmick 1982), and northwestern Colorado (T. Fratt, Routt National Forest, pers. comm.; D. Vos, White River National Forest, pers. comm.).

Strategies for restricting anglers have varied. Many Wyoming populations are protected by fishing closures or catch-and-release regulations.

Similarly, Colorado has prohibited harvest and mandates the use of artificial flies and lures in some waters containing this subspecies. Utah chose not to apply special regulations to certain streams containing this subspecies to avoid attracting public attention (Schmidt et al. 1995).

Most conservation and management plans (e.g., Speas et al. 1994) for the Colorado River cutthroat trout emphasize barrier (permanent, physical obstructions; e.g., installing rock weirs) construction to protect existing populations, or barrier construction and chemical treatment (fish removal) to prepare the waters for reintroduction (e.g., West Beaver Creek, Colorado and Clear Creek, Wyoming). An alternative to chemical treatment is depletion-removal electrofishing. The advantage of this method is that nontarget fish, such as Colorado River cutthroat trout, are not killed; nonetheless, complete elimination of undesirable species may be impossible (Thompson 1995). Agencies have also installed channel structures to increase habitat quantity and quality, and are modifying land management to improve stream habitat.

METHODS

We used three techniques to obtain information on the status and distribution of Colorado River cutthroat trout within their historical range. First, we sent two questionnaires to state and federal biologists responsible for managing waters known or suspected to contain Colorado River cutthroat trout in Utah, Wyoming, and Colorado. Second, we obtained data from publications, reports, and personal contacts. Third, we searched the computerized databases maintained by the Colorado Division of Wildlife and the Wyoming Game and Fish Department for references to Colorado River cutthroat trout and for records of stocking in waters believed to contain this subspecies.

Information obtained from the first questionnaire included the name and location of waters known to contain Colorado River cutthroat trout, the non-native trout present, the genetic purity of Colorado River cutthroat trout and mode of determination, and the land management activities affecting the water. After assembling this information, we prepared a follow-up questionnaire that was submitted to the same biologists. The second questionnaire included questions on population origin and the presence of a barrier to upstream migration.

Because not all biologists responded to our pleas for information, the list of populations and their characteristics is inaccurate. In many cases, waters with marginal populations have not been recently revisited, and some of these populations may now be extinct. Similarly, stocking records were limited. The computerized database for Colorado only contains records since 1973, and earlier stocking was not consistently reported. Also, we were unclear about the identity of certain waters; some were unnamed on maps or had names different than those on U.S. Geological Survey maps. Unauthorized stocking by anglers could not be documented and perhaps not all stocking by state or federal agencies was entered in the database. These same concerns pertain to Wyoming. Few records of any kind could be obtained from Utah.

We used the terms "population" and "water" interchangeably because we could not distinguish between distinct populations that occupied the same body of water (e.g., perhaps in Trappers Lake, Colorado; Thurow et al. 1988) or determine when a single population occupied more than one stream or lake (e.g., perhaps in the North Fork Little Snake River, Wyoming; Fausch and Young 1995). Our convention may be appropriate for most populations of Colorado River cutthroat trout because they are isolated in relatively short stream reaches.

We believe that this list of waters is a critical benchmark in assessing the status of Colorado River cutthroat trout and for gaging the success or failure of future conservation efforts. We hope field biologists will direct future efforts to correcting our errors and oversights.

RESULTS AND DISCUSSION

We estimate that 318 populations of Colorado River cutthroat trout still exist within the historical range of this subspecies in Utah, Wyoming, and Colorado (Table 1; Appendix A; Appendix B). This total is provisional because the inclusion of some waters is controversial, for the following reasons.

Table 1. Summary of characteristics for populations of Colorado River cutthroat trout in Utah, Utah-Wyoming, Wyoming, and Colorado waters. All numbers refer to the number of populations.

Characteristics	UT	UT-WY	WY	CO	Total
Total populations	17	30	119	152	318
Nonindigenous populations[1]	1	8	29	17	55
Genetic purity					
Pure	11	3	25	44	83
Hybridized	2	20	51	59	132
Mixed results	3	3	4	5	15
Not tested	1	4	39	44	88
Genetic technique					
Meristics	5	18	79	108	210
Protein electrophoresis	4	10	9	4	27
mtDNA analysis	16	5	1	0	22
Non-native species					
Waters with sympatric populations	5	14	68	55	142
of brook trout	4	11	62	50	127
of brown trout	2	0	5	3	10
of non-native cutthroat trout	2	1	0	0	3
of rainbow trout	2	7	20	11	40
Waters stocked since 1973	0	7	20	70	97
with brook trout	0	0	0	20	20
with brown trout	0	0	0	3	3
with non-native cutthroat trout	0	4	17	54	75
with rainbow trout	0	2	5	33	40
Recently stocked in headwaters	0	2	0	24	26
Waters with barriers[2]					
Yes	1	3	26	59	89
No	0	1	72	28	101
Breached	0	0	14	6	20
Unknown	16	26	7	59	108
Land management effects					
Dewatering	5	1	13	3	22
Grazing	6	2	6	15	29
Logging	1	1	0	0	2
Mining	0	0	4	2	6
Road erosion	3	2	12	2	19

[1] *Populations established or supplemented by stocking of genetically pure fish.*

[2] *Permanent, physical obstructions to upstream migration; non-native species are present above a breached barrier.*

Reintroduced populations

All three states have re-established or created new populations of genetically pure Colorado River cutthroat trout; 17% of all waters have received such nonindigenous fish (those established or supplemented by stocking of genetically pure fish). The population in Durfey Creek, Utah, was translocated from nearby East Fork Boulder Creek. A hatchery stock from trout in Rock Creek 2, Wyoming, supplemented or founded populations in Wyoming and Utah-Wyoming waters.

Similarly, a stock from trout in Williamson Lakes, California, which originated from Trappers Lake, Colorado in 1931 (Pister 1990), was used in Colorado waters. Some of these waters, especially lakes (e.g., Big Sheep Mountain Lake, Wyoming and Bench Lake, Colorado), were probably historically barren. They were included, but whether they should be considered "restored" populations is debatable.

Not all attempts to maintain or restore populations of Colorado River cutthroat trout have succeeded. Populations above barriers in some streams (e.g., Irene and Nameless Creeks, Wyoming) are apparently not self-sustaining, but rely on repeated stocking (Thompson 1995). Perhaps inadequate or insufficient habitat prevented successful re-establishment of these populations. Alternatively, hatchery populations founded by migratory or lacustrine stocks may be maladapted for restoring Colorado River cutthroat trout to small, fragmented streams.

Genetic purity

Only 26% of the remaining populations of Colorado River cutthroat trout were judged to be genetically pure (Table 1). In contrast, 42% were thought to be introgressed with genes from rainbow trout or nonindigenous stocks of cutthroat trout; 28% remain unevaluated. Though genetic analysis is critical, absolute confidence in purity designation is unjustified because of technique or sampling method deficiencies. As evidence, 15 populations have been judged both genetically pure and introgressed. Many of these mixed conclusions resulted from meristic analyses, which are based on counts or the presence of certain anatomical characters, conducted by different individuals at different times (e.g., Northwater and Cunningham Creeks, Colorado). Though the populations may have become hybridized in the interval between samples, it is also likely that different meristic analyses conflicted because the method is highly subjective (Hubert and Alexander 1995). The accuracy of meristic analysis is also suspect because of the lack of experimental studies comparing meristic counts of pure fish, their first-generation hybrids and backcrosses (a first-generation hybrid mated with a parent), and the absence of assessments of the statistical reliability of these counts. One of the characteristics thought to be an indicator of hybridization with rainbow trout, the absence of basibranchial teeth, has been demonstrated to be unreliable (Leary et al. 1996). Meristic analysis may also be less sensitive than other techniques (Campton 1987) because meristic variation may have environmental and genetic components (Leary et al. 1985). Meristic analysis of purity should be considered an interim assessment until other techniques are applied.

Partly due to the high costs of these methods, only 49 populations have been genetically evaluated by using protein electrophoresis (Leary et al. 1993) or by examining mitochondrial DNA (Shiozawa and Evans 1995a). These techniques are less subjective, but still suffer shortcomings for evaluating genetic characteristics (Campton 1987; Utter 1987; R.J. Behnke, Colorado State University, pers. comm.), which produced conflicting designations of purity (e.g., Currant and South Fork Sheep Creeks, Utah). We have the greatest confidence in the genetic evaluations for populations judged free from hybridization by all three methods (e.g., Beaver Creek, Utah, and Rock Creek 2, Wyoming). Unfortunately, for some hybrids, such as greenbacks crossed with Colorado River cutthroat trout, there may be no technique that reliably distinguishes them from the parent stock (Behnke 1992; R. Leary, University of Montana, pers. comm.).

Non-native trout

The introduction and subsequent spread of nonnative trout may be the greatest threat to the continued existence of populations of Colorado River cutthroat trout (Behnke 1992). Almost 45% of the remaining populations are at least partly sympatric with non-native species or stocks (Table 1). Brook trout occurred in nearly 90% of these sympatric populations and rainbow trout in 28%. Brook trout have been widely reported to replace Colorado River cutthroat trout (Oberholtzer 1987; Behnke 1992; Thompson 1995), and hybridization with rainbow trout has been repeatedly documented (Leary 1990; Behnke 1992; Bischoff 1995).

Non-native salmonids have been stocked in the historical range of Colorado River cutthroat trout for over 100 years. Such stocking began in 1872 in Colorado (Wiltzius 1985). Brook and rainbow trout were first introduced in 1880 in Wyoming, and brown trout were first stocked 10 years later (Wiley 1993). In the North Fork Little Snake River drainage in Wyoming, rainbow trout were first introduced in 1950 and Yellowstone cutthroat and brook trout in 1936 (Oberholtzer 1987). In the Savery Creek drainage, tributary to the Little Snake River, rainbow, brook, and brown trout were first introduced in 1936 and fine-spotted or Yellowstone cutthroat trout may have been introduced as early as 1933 (Eiserman 1958). Rainbow trout were first stocked in 1915 in the Smiths Fork, a tributary to the Green River in Wyoming (M. Fowden, Wyoming Game and Fish Department, pers. comm.). Rainbow, brook , brown, golden, and lake trout and coho salmon were introduced into the northern and eastern portions of the Green River drainage before 1934 (Simon 1935), which probably explains the complete absence of indigenous populations of Colorado River cutthroat trout in that portion of the watershed.

Stocking of non-native trout continues to threaten Colorado River cutthroat trout. Of the waters considered to support this subspecies, 30% have been recently stocked. Many streams on public land in Utah, Wyoming, and Colorado with road crossings, which allow for stocking by automobiles, or with headwater lakes, which allow for stocking by aircraft, have introduced populations of non-native trout. Because some of these waters (e.g., Porcupine Lake, Lake of the Crags, and Lake Diana, Colorado) have been repeatedly stocked with nonindigenous forms of cutthroat trout, they probably should not be included in the remaining range of this subspecies. However, they have been included in this assessment.

Recent stocking has been extensive. For example, of the 152 waters believed to contain remnant populations of Colorado River cutthroat trout in Colorado, 70 have been directly stocked with non-native trout or have had presumably connected portions of their watersheds stocked. Sixty-three of the 70 waters have been stocked with species or subspecies likely to hybridize with Colorado River cutthroat trout. These stocks include rainbow trout, Pikes Peak cutthroat [1], Snake River fine-spotted cutthroat, Trappers Lake cutthroat [2], and Yellowstone cutthroat trout.

Barriers

The majority of waters containing Colorado River cutthroat trout have not been surveyed for migration barriers. Only 28% of the waters with indigenous trout populations are known to have barriers that protect those populations from invasions by non-native stocks (Table 1). Although what constitutes a natural barrier to migration has not been quantitatively defined, many barriers are human-made structures designed to prevent fish passage. In Wyoming, such structures are at least 1 m high with a downstream apron typically extending over 2 m (Ed Novotny, Wyoming Game and Fish Department, pers. comm.). Human-made barriers are less permanent than geologic barriers; high flows in 1995 severed a 10-month-old weir in West Beaver Creek, Colorado.

Twenty waters possess barriers that have been breached by non-native trout species. Headwater introductions by government agencies may account for some of these instances, and improper design or maintenance may have enabled brook trout to scale some barriers (e.g., Nameless and Deep Creeks, Wyoming). The most insidious threats to populations of Colorado River cutthroat trout above barriers are illegal introductions by anglers. This activity often enables non-native trout to reproduce and spread before they are detected by management agencies. For example, when sampling the North Fork Little Snake River above a barrier in 1995, we discovered at least three age classes of brook trout distributed over 4 km, suggesting that adults were probably introduced in 1993 (M. Young, unpub. data). This illegal introduction may jeopardize the future of the largest population of indigenous Colorado River cutthroat trout in Wyoming.

[1]Greenback cutthroat trout that have hybridized with Yellowstone cutthroat and Snake River fine- spotted cutthroat trout (D. Krieger, Colorado Division of Wildlife, pers. comm.).

[2]Colorado River cutthroat trout that have hybridized with Yellowstone cutthroat trout and rainbow trout (Martinez 1988; Leary 1990).

Land management

Grazing, stream-dewatering, and roads were the most frequently identified problems for waters containing Colorado River cutthroat trout. But the effects of land management were rarely noted by most biologists responding to the questionnaire and may be more widespread than reported. Land management problems were usually noted for well-studied watersheds. For example, water diversion structures and roads for the Cheyenne Stage II water diversion project in the North Fork Little Snake River watershed accounted for most these effects in Wyoming (Appendix A).

Population status

Fluvial populations (individuals migrating between rivers and streams or between different streams) of Colorado River cutthroat trout have been extirpated from most large streams and rivers throughout their historic range. The North Fork Little Snake River may contain the longest contiguous, available habitat of 27.8 km (Oberholtzer 1990). Similarly, indigenous populations of adfluvial Colorado River cutthroat trout (individuals migrating between lakes and streams) have almost been eliminated from their historic range. Of the 318 waters containing this subspecies, only 24 are lakes or reservoirs and only two indigenous populations have escaped extensive introductions of non-native stocks. These populations are in the Fryingpan Lakes in Colorado, which may lack a barrier, and North Piney Lake in Wyoming, which nevertheless contains brook trout. Yet adfluvial stocks have been readily re-established and could be a priority for further restoration.

Most of the occupied range of this subspecies consists of isolated segments of small streams on public land; only Miller and Smith Creeks in Colorado and Van Tassel Creek in Wyoming are largely private. This fragmentation resulted from human-built structures (e.g., culverts and water diversions) that blocked upstream fish movement, and from non-native salmonids in lower reaches that seemingly prevented recolonization by Colorado River cutthroat trout. Populations of Colorado River cutthroat trout in these segments are probably at risk of short-term extinction particularly from events such as fire, flood, toxic spills, or one-time stocking of non-native fish (Rieman and McIntyre 1993). But in several locations, connected networks of streams enable individuals to move freely or connections could be restored by non-native fish removal and downstream barriers (Table 2). Such networks could be the focus of restoration (Moyle and Yoshiyama 1994). Linking populations may reduce their risk of extinction by providing some habitats likely to be unaffected by a single environmental disturbance (Shaffer 1987). For this reason, Wyoming intends to chemically remove all non-native fish from the lower reaches of the West Branch and the mainstem of the North Fork Little Snake River downstream to a geologic barrier (M. Fowden, Wyoming Game and Fish Department, pers. comm.). This would reconnect two of the largest populations of Colorado River cutthroat trout in the Little Snake River watershed.

Table 2. Potential sites for restoration of connectivity between populations.

Utah-Wyoming
Upper Henrys Fork
Upper Blacks Fork
Wyoming
North Fork Little Snake River
West Branch North Fork Little Snake River
LaBarge Creek
Hams Fork
Cottonwood Creek
Piney Creek
Colorado
Upper Piedra River
South Fork Little Snake River
East Fork Parachute Creek
Thompson Creek
South Fork Ranch Creek
Little Muddy Creek
Little Green Creek

Immediate needs

As a consequence of the introduction of non-native species, historical overharvest (Behnke 1992), improper land management, and a lack of knowledge about this subspecies, the continued existence of Colorado River cutthroat trout is in doubt. Of the 318 waters believed to contain this subspecies, only 20 may support populations that are indigenous, genetically pure, allopatric above a

barrier, and in a drainage not recently stocked. We consider these "conservation populations" because of their importance as regionally adapted stocks, which might be used to restore populations to nearby waters, and because they may be temporarily secure. Despite this standing, such populations may be too small to remain viable. The overall status of this subspecies may be much worse or only marginally better than we have depicted because of what we do not know. For example, many populations have not been genetically tested, only 12 of those considered genetically pure have been evaluated with more than one technique, and we cannot confirm the presence of a barrier for 25 waters containing purportedly genetically pure populations. Many waters that we included have not been examined for over 20 years and may no longer contain Colorado River cutthroat trout. Finally, historically barren waters and those that have been intensively stocked make a dubious contribution to the total number of populations. Because lakes and accessible streams have experienced intensive fish management, retention of unrecognized, indigenous populations of this subspecies is unlikely. But small streams that are rarely visited by anglers, biologists, or fish culturists may contain remnant populations of Colorado River cutthroat trout. Clusters of such streams may persist in the Gunnison and Dolores river basins in Colorado or the upper Blacks Fork and Strawberry river basins in Utah. Because small streams seem the most likely to contain barriers to upstream migration, these populations may represent the best remaining genetic examples of the subspecies.

Biologists have several tactics for increasing the knowledge of the status and distribution of Colorado river cutthroat trout. We recommend that biologists examine the state databases to identify waters that have not been recently stocked or sampled, or to find waters that other biologists have not noticed. Electrofishing, or visual or hook-and-line surveys in remote waters are effective in identifying populations of Colorado River cutthroat trout and may provide information on the characteristics, location, and permanence of natural barriers. Populations protected by a natural barrier or an old human-made barrier, such as a water diversion, or those with good phenotypic characteristics are likely candidates for genetic testing. Finally, noting the location of existing populations may lead to the discovery of nearby populations and will enable biologists to recognize streams of importance to the conservation of Colorado River cutthroat trout.

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Appendix A.

Characteristics of populations of Colorado River cutthroat trout in Utah, Utah-Wyoming, Wyoming, and Colorado waters. Waters are listed from downstream to upstream within each state.

Water[1]	Drainage	Genetic purity[2]	Tech-nique[3]	Non-native species Present[4]	Non-native species Stocked[5]	Barr.[6]	Activity[7]	In Appendix B Figure[8]	In Appendix B Water#[9]
UTAH									
Escalante R.									
E. Fk. Boulder Cr.†	Boulder Cr.	p	m,d	bk,rb	?	y	—	1	1
W. Fk. Boulder Cr.	Boulder Cr.	p	d	—	?	u	—	1	2
Durfey Cr.*	W. Fk. Boulder Cr.	p	d	—	?	u	—	1	3
Duchesne R.									
Whiterocks R.	Uinta R.	u	—	bk	?	u	g,r,l	2	4
Reader Cr.	Whiterocks R.	p	d	?	?	u	—	2	5
Yellowstone R.	Lake Fork R.	p	d	bk,bn,ct	?	u	d,g	2	6
Avintaquin Cr.	Strawberry R.	m	m,d	—	?	u	d,g	3	7
Currant Cr.	Red Cr.	m	e,d	?	?	u	—	3	8
Racetrack Cr.	Currant Cr. Res.	p	d	?	?	u	—	3	9
Timber Canyon	Strawberry R.	p	d	—	?	u	d,g,r	3	10
Willow Cr.	Strawberry R.	h	d	bn,ct,rb	?	u	d,g,r	3	11
W. Fk. Duchesne R.	Duchesne R.	p	d	?	?	u	—	3	12
Green R.									
Dry Fk. Ashley Cr.	Ashley Cr.	p	d	bk	?	u	d,g	2	13
Dolores R.									
Geyser Cr.	Roc Cr.	h	d	?	?	u	—	4	14
La Sal Cr.	Dolores R.	m	m,e,d	?	?	u	—	4	15
Beaver Cr.	La Sal Cr.	p	m,e,d	?	?	u	—	4	16
Mid. Fk. Beaver Cr.	Beaver Cr.	p	m,e,d	?	?	u	—	4	17
UTAH-WYOMING									
Green R.									
Red Cr.*	Green R.	p	m	bk	—	u	—	5	18
Carter Cr.	Flaming Gorge Rs.	u	—	bk,ct,rb	?	u	d,g,l,r	2	19
N. Fk. Sheep Cr.	Sheep Cr.	p	e,d	?	?	u	—	2	20
S. Fk. Sheep Cr.	Sheep Cr.	m	e,d	bk	?*	u	—	2	21
Henrys Fk.	Green R.	h	m,e	rb	src	u	—	2	22
Birch Cr.*	Henrys Fk.	h	m	—	src,rb	u	—	2	23
Burnt Fk.	Henrys Fk.	p	d	—	—	u	—	2	24
W. Beaver Cr.*	Henrys Fk.	h	m	—	src	u	—	2	25
Poison Cr.	Henrys Fk.	h	m	rb	—	n	—	2	26
Dahlgreen Cr.	Henrys Fk.	h	e	?	?	u	—	2	27
Currant Cr.*	Green R.	h	m	bk	—	u	—	5	28
Blacks Fk.									
Blacks Fk.	Green R.	h	m	rb	—	u	—	2	29
E. Muddy Cr.	Muddy Cr.	h	m	—	—	u	—	2	30
W. Muddy Cr.	Muddy Cr.	h	m	—	rb	u	—	2	31
Van Tassel Cr.	W. Muddy Cr.	h	m	—	—	u	—	2	32
Cottonwood Cr.*	Smiths Fk.	u	—	bk	—	u	—	2	33
Sage Cr.	Cottonwood Cr.	h	m	—	src	y	g,r	2	34
Swamp Cr.*	Cottonwood Cr.	u	—	bk	—	u	—	2	35
Willow Cr.	Smiths Fk.	h	m	—	—	u	—	2	36
E. Fk. Smiths Fk.*	Smiths Fk.	u	—	bk,rb	—	u	—	2	37
Gilbert Cr.*	E. Fk. Smiths Fk.	h	m,e	bk,rb	—	y	—	2	38
Little Gilbert Cr.	Gilbert Cr.	m	m,e	bk	—	u	—	2	39
W. Fk. Smiths Fk.	Smiths Fk.	h	m,e	bk,rb	—	u	—	2	40
Archie Cr.	W. Fk. Smiths Fk.	h	m,e	—	—	u	—	2	41

Appendix A. Cont'd.

Water[1]	Drainage	Genetic purity[2]	Tech-nique[3]	Non-native species Present[4]	Non-native species Stocked[5]	Barr.[6]	Activity[7]	In Appendix B Figure[8]	In Appendix B Water#[9]
UTAH-WYOMING (Cont'd.)									
Green R. (Cont'd.)									
Little W. Fk. Blacks Fk.	Meeks Cabin Res.	m	m	—	—	y	—	2	43
E. Fk. Blacks Fk.	Blacks Fk.	h	e	?	?	u	—	2	44
Little E. Fk. Blacks Fk.	E. Fk. Blacks Fk.	h	e	bk	?*	u	—	2	45
W. Fk. Blacks Fk.	Blacks Fk.	h	d	—	—	u	—	2	46
Middle Fk. Blacks Fk.	W. Fk. Blacks Fk.	h	d	—	—	u	—	2	47
Horse Cr.	Blacks Fk.	h	m	?	—	u	—	2	42
WYOMING									
Little Snake R.									
Deep Cr.	Big Sandstone Cr.	h	m	bk	—	y	—	6	48
E. Branch Deep Cr.	Deep Cr.	m	m,e	bk	—	y	—	6	49
W. Branch Deep Cr.	Deep Cr.	u	—	bk	rb	y	—	6	50
Mill Cr.	Big Sandstone Cr.	h	m	bk	—	b	—	6	51
S. Fk. Mill Cr.	Mill Cr.	u	—	bk	—	y	—	6	52
Elk Cr.	Mill Cr.	h	m	—	—	y	—	6	53
Right Branch Mill Cr.	Mill Cr.	u	—	bk	—	y	—	6	54
Skull Cr.	Big Sandstone Cr.	h	m	bk	—	n	—	6	55
Big Sandstone Cr. AC	Big Sandstone Cr.	p	m	bk	—	u	—	6	56
N. Fk.	Big Sandstone Cr.	p	m	bk	—	u	—	6	57
Hell Canyon	Savery Cr.	h	m	—	—	y	—	6	58
Dirtyman Fk. Savery Cr.	Savery Cr.	h	m	—	ct,rb	y	—	6	59
Hatch Cr.	E. Fk. Savery Cr.	h	m	—	—	y	—	6	60
Carrico Reservoir*	Hatch Cr.	h	m	—	—	y	—	6	61
Beaver Cr.	Joe Cr.	p	m	—	—	u	—	6	62
Haggarty Cr.	W. Fk. Battle Cr.	u	—	—	ct	n	m	6	63
Green Cr.	Haggarty Cr.	p	m	—	—	n	m	6	64
Alisha Cr.	Haggarty Cr.	p	m	—	—	n	m	6	65
Bachelor Cr.	Haggarty Cr.	p	m	—	—	n	m	6	66
Lost Cr.	W. Fk. Battle Cr.	u	—	bk	ct	n	—	6	67
Roaring Fk.†	Little Snake R.	p	m,e	bk	ct	y	—	6	68
N. Fk. Little Snake R.	Little Snake R.	m	m,e	bk	rb,yc	b	d,r	6	69
W. Branch	N. Fk. Ltl. Snake R.	h	m	bk	ct	y	d,r	6	70
Deadline Cr.	W. Branch	u	—	bk	—	y	d,r	6	71
Rabbit Cr.	W. Branch	h	m	bk	—	y	d,r	6	72
Standard Cr.	W. Branch	h	m	—	—	y	d,r	6	73
Solomon Cr.	N. Fk. Little Snake	p	m,e	—	—	b	d,r	6	74
Rose Cr.	N. Fk. Little Snake	h	m	—	—	b	d,r	6	75
Harrison Cr.	N. Fk. Little Snake	h	m	—	—	b	d,r	6	76
Green Timber Cr.	N. Fk. Little Snake	h	m	—	—	b	d,r	6	77
Deadman Cr.	N. Fk. Little Snake	h	m	—	—	b	d,r	6	78
Third Cr.	N. Fk. Little Snake	h	m	—	—	y	d,r	6	79
Ted Cr.†	N. Fk. Little Snake	p	m,e	—	—	y	d,r	6	80
Dale Cr.†	N. Fk. Little Snake	p	m	—	—	y	—	6	81
Upper N. Fk.†	N. Fk. Little Snake	p	e	—	—	y	—	6	82
Green R.									
Trout Cr.*	Sage Cr.	h	m	—	src	y	d,g	5	83
Little Indian Cr.	Hams Fk.	h	m	rb	—	n	—	7	84
Devils Hole Cr.	Hams Fk.	p	m	bk,rb	—	n	—	7	85
Game Trail Cr.	Devils Hole Cr.	u	—	rb	—	y	—	7	86
Faucet Cr.	Devils Hole Cr.	u	—	—	—	u	—	7	87
Sculpin Cr.	Big Sandy R.	u	—	bn,rb	—	n	—	8	88

Appendix A. Cont'd.

Water[1]	Drainage	Genetic purity[2]	Tech-nique[3]	Non-native species Present[4]	Stocked[5]	Barr.[6]	Activity[7]	In Appendix B Figure[8]	Water#[9]
WYOMING (Cont'd.)									
Green R. (Cont'd.)									
S. Fk. Fontenelle Cr.	Fontenelle Cr.	u	—	bk	—	n	—	7	89
LaBarge Cr.*	Green R.	u	—	bk,bn,rb	—	n	—	7	90
Rock Cr. 2†	LaBarge Cr.	p	m,e,d	—	—	y	—	7	91
Little Fall Cr.	LaBarge Cr.	u	—	bk	—	n	—	7	92
Little Hornet Cr.	LaBarge Cr.	h	m	bk,rb	—	n	—	7	93
Big Fall Cr.	LaBarge Cr.	u	—	rb	—	n	—	7	94
Turkey Cr.	LaBarge Cr.	u	—	bk,rb	—	n	—	7	95
Bald Hornet Cr.	LaBarge Cr.	u	—	bk	—	n	—	7	96
Shafer Cr.	LaBarge Cr.	u	—	?	—	n	—	7	97
Packsaddle Cr.	LaBarge Cr.	u	—	?	—	n	—	7	98
S. LaBarge Cr.	LaBarge Cr.	m	m	bk,rb	—	u	—	7	99
Mack Cr.	S. LaBarge Cr.	u	—	bk	—	n	—	7	100
Nameless Cr.*	LaBarge Cr.	h	m	bk,rb	—	b	—	7	101
Road Cr.	LaBarge Cr.	u	—	bk	—	n	—	7	102
Spring Cr. 2	LaBarge Cr.	p	m,e	bk	—	n	—	7	103
Clear Cr.*	LaBarge Cr.	p	m	bk	—	b	—	7	104
Trail Cr.	LaBarge Cr.	h	m	bk	—	n	—	7	105
Dry Piney Cr.	Green R.	u	—	bk	—	n	—	7	106
Fogarty Cr.*	Dry Piney Cr.	u	—	bk	—	n	—	7	107
Pine Grove Cr.*	Fogarty Cr.	p	m	—	—	n	—	7	108
Black Canyon Cr.	Dry Piney Cr.	u	—	bk	—	n	—	7	109
Beaver Cr.	S. Piney Cr.	u	—	—	—	n	—	7	110
Spring Cr.	Beaver Cr.	h	m	rb	—	n	—	7	111
Trail Ridge Cr.	Beaver Cr.	h	m	—	—	n	—	7	112
N. Beaver Cr.†	Beaver Cr.	p	m	—	—	y	—	7	113
Mid. Beaver Cr.	Beaver Cr.	h	m	—	—	n	—	7	114
S. Beaver Cr. 1	Beaver Cr.	h	m	rb	—	n	g	7	115
Fish Cr.*	S. Piney Cr.	u	—	bk,rb	src	n	—	7	116
N. Fk. Fish Cr.*	Fish Cr.	u	—	—	—	n	—	7	117
Porcupine Cr.	S. Piney Cr.	u	—	bk	—	n	—	7	118
Apperson Cr.	N. Piney Cr.	u	—	bk	src	n	—	9	119
Lake Cr.	N. Piney Cr.	h	m	bk	—	n	—	9	120
N. Piney L.	N. Piney Cr.	h	m	bk	—	n	—	9	121
N. Piney Cr.*	Green R.	h	m	bk	src	n	—	9	122
Muddy Cr.	Green R.	u	—	—	—	n	—	9	123
S. Muddy Cr.	Muddy Cr.	u	—	—	src	n	—	9	124
N. Muddy Cr.	Muddy Cr.	h	m	—	—	n	—	9	125
L. August*	N. Fk. Boulder Cr.	p	m	—	—	n	—	10	126
Sunrise L.*	S. Fk. Boulder Cr.	p	m	—	—	y	—	10	127
Little Cottonwood Cr.	S. Cottonwood Cr.	h	m	—	—	n	—	9	128
Beecher Cr.	Little Cottonwood	u	—	—	—	n	—	9	129
Camp Cr.*	Beecher Cr.	h	m	—	—	n	—	9	130
Red Castle Cr.	Little Cottonwood	h	m	—	—	n	—	9	131
S. Cottonwood Cr.*	Cottonwood Cr.	h	m	bk,rb	src	n	g	9	132
Bare Cr.*	S. Cottonwood Cr.	h	m	bk	—	b	g	9	133
N. Cottonwood Cr.*	Cottonwood Cr.	h	m	bk,rb	src	n	—	9	134
Maki Cr.	N. Cottonwood Cr.	h	m	—	—	n	—	9	135
Irene Cr.*	N. Cottonwood Cr.	h	m	bk	—	b	—	9	136
Hardin Cr.*	N. Cottonwood Cr.	p	m	bk	—	b	—	9	137
Nylander Cr.*	N. Cottonwood Cr.	p	m	bk	—	b	—	9	138
Ole Cr.	N. Cottonwood Cr.	u	—	bk	—	n	—	9	139

Appendix A. Cont'd.

Water[1]	Drainage	Genetic purity[2]	Tech-nique[3]	Non-native species Present[4]	Non-native species Stocked[5]	Barr.[6]	Activity[7]	In Appendix B Figure[8]	In Appendix B Water#[9]
WYOMING (Cont'd.)									
Green R. (Cont'd.)									
Sjhoberg Cr.	N. Cottonwood Cr.	m	m,e	bk	—	n	—	9	140
S. Horse Cr.	Horse Cr.	h	m	bk	—	n	—	9	141
Cole Cr.	S. Horse Cr.	u	—	—	—	n	—	9	142
Dead Cow Cr.	S. Horse Cr.	h	m	—	—	n	—	9	143
Camp Cr.*	S. Horse Cr.	h	m	—	—	n	—	9	144
N. Horse Cr.*	Horse Cr.	h	m	bk,rb	src	n	g	9	145
Lead Cr.	N. Horse Cr.	p	m	bk	—	n	g	9	146
N. Fk. N. Horse Cr.	N. Horse Cr.	h	m	bk	—	n	—	9	147
S. Fk. N. Horse Cr.	N. Horse Cr.	h	m	bk	—	n	—	9	148
S. Beaver Cr. 2	Green R.	h	m	bk,rb	—	n	—	9	149
Chall Cr.	S. Beaver Cr. 2	h	m	?	—	n	—	9	150
S. Fk. Chall Cr.	Chall Cr.	h	m	bk	src	n	—	9	151
Buck Cr.	S. Beaver Cr. 2	u	—	—	src	n	—	9	152
N. Fk. Mid. Beaver Cr.	N. Beaver Cr.	h	m	bk	—	n	—	9	153
Miner Cr.*	N. Beaver Cr.	u	—	bk	—	n	—	11	154
Packer Cr.*	N. Beaver Cr.	h	m	bk	—	n	—	11	155
Big Sheep Mountain L.*	Gypsum Cr.	p	m	—	—	y	—	11	156
Little Twin Cr.	Green R.	u	—	?	—	u	—	11	157
Big Twin Cr.	Green R.	u	—	?	—	u	—	11	158
Rock Cr. 3	Green R.	h	m	bk,bn,rb	rb	n	—	11	159
Trudy Cr.*	Rock Cr. 3	h	m	—	—	n	—	11	160
No Name Cr.*	Green R.	u	—	bk	—	n	—	11	161
Klondike Cr.*	Green R.	p	m	bk,bn,rb	—	y	—	11	162
Tosi Cr.	Green R.	u	—	bk,bn,rb	rb	b	—	11	163
Tepee Cr.*	Tosi Cr.	h	m	bk	src	n	—	11	164
Wagon Cr.	Green R.	u	—	bk	—	n	—	11	165
Beats Me Cr.*	Wagon Cr.	p	m	—	—	n	—	11	166
COLORADO									
San Juan R.									
S. Fk. Hermosa Cr.†	Hermosa Cr.	p	m	—	ppn	y	—	12	167
Deer Cr.†	Hermosa Cr.	p	m	—	rb,tlc	y	—	12	168
Big Bend Cr.	Hermosa Cr.	h	m	?	—	u	—	12	169
E. Fk. Hermosa Cr.*	Hermosa Cr.	p	m	—	—	y	—	12	170
E. Fk. Piedra R.†	Piedra R.	p	m	—	—	y	—	13	171
W. Fk. Navajo R.†	Navajo R.	p	m	—	—	y	r	13	172
Augustora Cr.†	W. Fk. Navajo R.	p	m	—	—	y	—	13	173
Himes Cr.	W. Fk. San Juan R.	u	—	—	—	y	—	13	174
White R.									
Lake Cr.	Cathedral Cr.	h	m	—	rb	u	—	14	175
Soldier Cr.	Cathedral Cr.	h	m	rb	—	u	—	14	176
Big Beaver Cr.	N. Fk. White R.	h	m	rb	rb	u	—	15	177
Fawn Cr.	N. Fk. White R.	u	—	bk	—	u	—	15	178
Lost Cr.	N. Fk. White R.	h	m	—	—	u	g	15	179
Hahn Cr.	Lost Cr.	p	m	—	—	u	g	15	180
Snell Cr.	N. Fk. White R.	p	m	bk	bk,tlc*	n	—	15	181
Little Skinny Fish L.*	Skinny Fish Cr.	h	m	—	rb,tlc	u	—	15	182
Trappers L.	N. Fk. White R.	m	m,e	bk,rb	rb,yc	u	—	15	183
Little Snake R.									
Willow Cr.	Little Snake R.	p	m	bk	—	n	—	16	184

Appendix A. Cont'd.

Water[1]	Drainage	Genetic purity[2]	Technique[3]	Non-native species Present[4]	Non-native species Stocked[5]	Barr.[6]	Activity[7]	In Appendix B Figure[8]	In Appendix B Water#[9]
COLORADO (Cont'd.)									
Little Snake R. (Cont'd.)									
Roaring Fk. Slater Cr.	Slater Cr.	u	—	bk	bk,ct,tlc	n	—	16	185
S. Fk. Slater Cr.	Slater Cr.	u	—	—	tlc	u	—	16	186
W. Prong S. Fk.	S. Fk. Slater Cr.	u	—	—	bk	u	—	16	187
S. Fk. Little Snake R.	Little Snake R.	u	—	bk	—	u	—	16	188
Johnson Cr.	S. Fk. Ltl. Snake R.	h	m	?	—	u	—	16	189
Oliver Cr.	S. Fk. Ltl. Snake R.	h	m	—	—	u	—	16	190
Lopez Cr.	S. Fk. Ltl. Snake R.	u	—	bk	—	n	—	16	191
Summit Cr.	Independence Cr.	u	—	—	rb	u	—	16	192
Yampa R.									
Beaver Cr. 1	S. Fk. Williams Fk.	u	—	—	bk,rb,tlc	u	—	15	193
Indian Run	Beaver Cr. 1	u	—	bk	bk	u	—	15	194
Poose Cr.	E. Fk. Williams Fk.	h	m	rb	rb*	n	—	15	195
Cyclone Cr.	Poose Cr.	u	—	—	—	u	—	15	196
Rough Cr.	Poose Cr.	u	—	—	rb	u	—	15	197
Baldy Cr.	E. Fk. Williams Fk.	u	—	bk	bk	u	—	15	198
Black Mountain Cr.	E. Fk. Williams Fk.	u	—	—	—	u	—	15	199
Little Cottonwood Cr.	Fortification Cr.	u	—	rb	ct,ppn,rb,tlc*	n	—	16	200
Freeman Res.	Little Cttwd. Cr.	u	—	rb	ct,ppn,rb,tlc	b	—	16	201
S. Fk. Fortification Cr.	Fortification Cr.	u	—	bk	—	u	—	16	202
First Cr.	Elkhead Cr.	h	m	bk,rb	bk,rb	n	—	16	203
Armstrong Cr.	Elkhead Cr.	u	—	bk	bk	u	—	16	204
Porcupine L.	S. Fk. Mad Cr.	h	m	—	ct,ppn,tlc	u	—	16	205
Luna L.	N. Fk. Mad Cr.	h	m	—	ct,ppn,tlc*	u	—	16	206
L. of the Crags	N. Fk. Mad Cr.	h	m	—	ct,ppn,tlc	u	—	16	207
Smith Cr.	Deep Cr.	u	—	—	—	u	—	16	208
Miller Cr.	Deep Cr.	h	m	—	—	n	—	16	209
Sand Cr. 1	Elk R.	u	—	—	—	u	—	16	210
Beaver Cr. 2	Willow Cr.	u	—	bk	bk,ppn	u	—	16	211
Lost Dog Cr.	N. Fk. Elk R.	h	m	bk	—	u	—	16	212
L. Diana	N. Fk. Elk R.	h	m	—	ct,ppn,tlc	u	—	16	213
W. Coal Cr.	Coal Cr.	u	—	—	rb	u	—	15	214
Dome Cr.	Bear R.	u	—	—	bk	u	—	15	215
Mandall Cr.	Bear R.	h	m	bk,bn,rb	bk,ct,ppn, rb,tlc*	b	—	15	216
Gunnison R.									
Jones Cr.	Cr. Fk. E. Muddy Cr.	u	—	—	—	y	—	17	217
Rock Cr.	Cr. Fk. E. Muddy Cr.	u	—	bk	—	n	—	17	218
N. Anthracite Cr.	Anthracite Cr.	u	—	—	ppn	u	—	17	219
Second Cr.	Smith Fk.	p	m	bk	—	u	g	18	220
Upper Lake Fk.*	Gunnison R.	u	—	bk	bk,bn,ct,ppn, rb,src,tlc*	b	—	12	221
W. Beaver Cr.*	Beaver Cr.	p	m	—	—	n	g	18	222
Colorado R.									
Roan Cr.	Colorado R.	p	m	?	—	u	—	14	223
E. Fk. Parachute Cr.	Parachute Cr.	h	m	bk	—	n	g	19	224
JQS Gulch	E. Fk. Parachute Cr.	h	m	bk	—	n	g	19	225
E. Mid. Fk.	Parachute Cr.	h	m	—	ct,rb	y	—	19	226
Northwater Cr.	E. Mid. Fk.	m	m	—	ct,rb	y	—	19	227
Trapper Cr.	E. Mid. Fk.	h	m	—	ct,rb	y	g	19	228
Battlement Cr.	Colorado R.	p	m	bk	ct,ppn,rb,tlc*	u	—	19	229

Appendix A. Cont'd.

Water[1]	Drainage	Genetic purity[2]	Tech-nique[3]	Non-native species Present[4]	Non-native species Stocked[5]	Barr.[6]	Activity[7]	In Appendix B Figure[8]	In Appendix B Water#[9]
Butler Cr.	Mid. Rifle Cr.	h	m	—	ct,ppn,rb,tlc	y	g	19	230
COLORADO (Cont'd.)									
Colorado R. (Cont'd.)									
Corral Cr.	Main Elk Cr.	h	m	bk	bk,bn,ct, rb,tlc	n	—	19	231
Mitchell Cr.†	Colorado R.	p	m	—	—	y	—	19	232
Cattle Cr.	Roaring Fk. R.	h	m	—	—	y	g	21	233
N. Thompson Cr.	Thompson Cr.	h	m	bk,bn,rb	bk,ct,rb,tlc	n	g,m,r	17	234
Park Cr.	N. Thompson Cr.	u	—	bk	—	n	g	17	235
Mid. Thompson Cr.	Thompson Cr.	h	m	—	ct,ppn,rb,tlc	u	m	17	236
Avalanche L.	Avalanche Cr.	h	m	bk,rb	ct,ppn,rb,tlc	n	—	17	237
Yule Cr.	Crystal R.	h	m	bk,rb	ct,ppn,tlc*	b	—	17	238
Lost Trail Cr.†	Crystal R.	p	m	—	—	y	—	17	239
Rocky Fk. Cr.†	Fryingpan R.	p	m	—	—	y	d,g	20	240
Cunningham Cr.	N. Fk. Fryingpan R.	m	m	bk,bn	—	y	—	20	241
Carter L.	Carter Cr.	h	m	—	—	u	—	20	242
S. Fk. Fryingpan R.	Fryingpan R.	u	—	—	—	u	—	20	243
Fryingpan Ls. 2 & 3	Fryingpan R.	p	m	—	—	u	—	20	244
Nickelson Cr.	Capitol Cr.	p	m	—	—	n	—	17	245
Hunter Cr.	Roaring Fk. R.	h	m	—	—	u	—	20	246
Difficult Cr.	Roaring Fk. R.	h	m	—	—	y	—	20	247
Abrams Cr.†	Brush Cr.	p	m	—	—	y	d,g	21	248
Hat Cr.†	Brush Cr.	p	m	—	—	y	—	21	249
Squaw Cr.	Eagle R.	u	—	bk	—	n	—	21	250
E. Lake Cr.	Lake Cr.	h	m	bk	ct,ppn,tlc*	y	—	21	251
Berry Cr.	Eagle R.	h	m	—	—	y	—	21	252
McCoy Cr.	Eagle R.	h	m	—	—	y	—	21	253
Booth Cr.	Gore Cr.	u	—	—	ct,ppn,tlc*	y	—	22	254
Pitkin Cr.	Gore Cr.	h	m	bk	ct,ppn,tlc*	y	—	22	255
Miller Cr.	Black Gore Cr.	h	m	bk	—	y	—	22	256
Polk Cr.	Black Gore Cr.	h	m	—	—	y	—	22	257
Cross Cr.	Eagle R.	m	m	bk	bk,ct,ppn, rb,tlc*	y	—	21	258
W. Cross Cr.	Cross Cr.	p	m	—	ct,ppn,rb,tlc*	y	—	21	259
Wearyman Cr.	Turkey Cr.	u	—	—	ct,tlc	n	—	22	260
Sopris Cr.	Homestake Cr.	h	m	—	ct,ppn,tlc*	u	—	20	261
Hack L.*	Hack Cr.	p	m	—	ct,ppn,tlc	y	—	15	262
Red Dirt Cr.	Colorado R.	h	m	—	—	y	—	15	263
E. Fk. Red Dirt Cr.	Colorado R.	h	m	—	—	y	—	15	264
W. Fk. Red Dirt Cr.	Colorado R.	h	m	—	—	y	—	15	265
Egeria Cr.	Harper Res.	u	—	bk	bk	u	—	15	266
E. Meadow Cr.	Meadow Cr.	p	m	—	—	u	—	22	267
Big Park Cr.	Blacktail Cr.	h	m	bk	—	n	d,g	23	268
Antelope Cr.	Muddy Cr.	u	—	?	—	u	—	23	269
Lindsey Cr.	Muddy Cr.	u	—	?	—	u	—	23	270
Frantz Cr.	Muddy Cr.	u	—	—	bk	u	—	23	271
Little Green Cr.	Muddy Cr.	h	m	—	—	y	—	23	272
N. Little Green Cr.†	Muddy Cr.	p	m	—	—	y	—	23	273
Blue R.									
N. Fk. Elliott Cr.	Elliott Cr.	h	m	?	bk,rb*	u	—	22	274
Cataract Cr.*	Blue R.	h	m	?	ct,ppn,rb,tlc*	u	—	22	275
L. 10794	Cataract Cr.	h	m	?	ct,rb,tlc	u	—	22	276

Appendix A. Cont'd.

Water[1]	Drainage	Genetic purity[2]	Tech-nique[3]	Non-native species Present[4]	Non-native species Stocked[5]	Barr.[6]	Activity[7]	In Appendix B Figure[8]	In Appendix B Water#[9]
Meadow Cr.	Dillon Res.	h	m	bk	—	y	—	22	277
Corral Cr.	W. Tenmile Cr.	p	m	bk	—	y	—	22	278
COLORADO (Cont'd.)									
Colorado R.									
Clinton Res.	Clinton Cr.	p	m	?	ppn,src	u	—	24	279
N. Fk. Swan R.	Swan R.	p	m	bk	ct	n	—	24	280
French Gulch†	Blue R.	p	m	—	—	y	—	24	281
Spruce Cr.*	Blue R.	h	m	—	bk,ct,gol, ppn,rb, rxc,tlc*	u	—	24	282
Long Draw	Haystack Cr.	u	—	bk	tlc	u	—	23	283
Paradise Cr.	E. Fk. Trblsm. Cr.	p	m	?	—	u	—	23	284
Timber Cr. 1	E. Fk. Trblsm. Cr.	p	m	?	—	u	—	23	285
Rabbit Ears Cr.	Troublesome Cr.	u	—	bk	—	u	—	23	286
Steelman Cr.	Williams Fk.	p	m	bk	—	y	—	25	287
McQueary Cr.	Williams Fk.	u	—	bk	ct,ppn,tlc*	u	—	25	288
Bobtail Cr.	Williams Fk.	p	m	bk	—	n	—	25	289
Little Muddy Cr.	Colorado R.	h	m	bk	ct,ppn	n	g	25	290
Cub Cr.	Little Muddy Cr.	h	m	bk	ct	n	—	25	291
Kelly Cr.	Little Muddy Cr.	h	m	bk	ct	n	—	25	292
Kinney Cr.*	Colorado R.	p	m	bk	—	y	—	26	293
Hamilton Cr.	Hurd Cr.	p	m	bk	—	y	—	25	294
Cabin Cr.	Ranch Cr.	h	m	bk	—	y	—	25	295
S. Fk. Ranch Cr.*	Ranch Cr.	h	m	—	—	n	—	25	296
Mid. Fk. Ranch Cr.	S. Fk. Ranch Cr.	u	—	—	—	y	—	25	297
Iron Cr.	St. Louis Cr.	u	—	—	ct,ppn,tlc*	y	—	25	298
Vasquez Cr.	Fraser R.	u	—	—	bk,rb	y	—	25	299
Little Vasquez Cr.†	Vasquez Cr.	p	m	—	—	y	—	25	300
S. Fk. Vasquez Cr.	Vasquez Cr.	p	m	—	—	n	—	25	301
Jim Cr.	Fraser R.	h	m	bk	ct	b	—	25	302
Trail Cr.	Willow Cr.	h	m	—	—	y	—	26	303
Roaring Fk.	L. Granby	h	m	—	ct,ppn,tlc*	y	—	26	304
Watanga Cr.	Roaring Fk.	u	—	—	ct,ppn,tlc*	y	—	26	305
Watanga L.	Watanga Cr.	u	—	—	ct,ppn,tlc	y	—	26	306
Arapaho Cr.	Monarch L.	h	m	bk	bn,ct,ppn, rb,tlc*	b	—	26	307
Buchanan Cr.	Arapaho Cr.	h	m	—	ct,ppn,rb,tlc*	u	—	26	308
Thunderbolt Cr.	Buchanan Cr.	h	m	—	tlc*	n	—	26	309
Columbine Cr.	Colorado R.	m	m	—	—	y	—	26	310
Paradise Cr.*	E. Inlet	p	m	—	—	y	—	26	311
Adams L.*	Paradise Cr.	p	m	—	—	y	—	26	312
Fifth L.*	E. Inlet	p	m	—	—	y	—	26	313
Ptarmigan Cr.*	N. Inlet	p	m,e	—	—	y	—	26	314
Bench L.*	Ptarmigan Cr.	p	m,e	—	—	y	—	26	315
L. Nanita*	N. Inlet	p	m,e	—	—	y	—	26	316
Timber Cr. 2*	Colorado R.	p	m	—	—	y	—	26	317
Timber L.*	Timber Cr.	p	m	—	—	y	—	26	318

[1]*Water*

* = *population established or supplemented by stocking of nonindigenous, genetically pure fish*
† = *a conservation population (believed to be indigenous, genetically pure, allopatric above a barrier; and not believed to be in a recently stocked watershed)*

Appendix A. Cont'd.

[2]*Genetic purity*	*p*	=	*genetically pure*
	h	=	*hybridized*
	m	=	*mixed results*
	u	=	*unknown (not tested)*
[3]*Technique*	*Techniques used in genetic analysis*		
	m	=	*meristic analysis*
	e	=	*electrophoretic analysis of proteins*
	d	=	*analysis of mtDNA*
	dash	=	*no analysis performed*
[4]*Present*	*Presence of sympatric populations of non-native species*		
	bk	=	*brook trout*
	bn	=	*brown trout*
	ct	=	*unknown subspecies of cutthroat trout (probably not indigenous)*
	gol	=	*golden trout*
	ppn	=	*Pikes Peak cutthroat trout (greenback cutthroat trout introgressed with Yellowstone cutthroat trout and possibly Snake River cutthroat trout)*
	rb	=	*rainbow trout*
	rxc	=	*rainbow-cutthroat trout hybrid*
	src	=	*Snake River fine-spotted cutthroat trout*
	tlc	=	*Trappers Lake cutthroat trout (Colorado River cutthroat trout introgressed with Yellowstone cutthroat trout and possibly rainbow trout)*
	yc	=	*Yellowstone cutthroat trout*
	—	=	*non-native species believed absent*
	?	=	*presence of non-native species not determined*
[5]*Stocked*	*Water stocked since 1973; species codes are as above*		
	—	=	*water (or nearby, connected waters) was not believed stocked since 1973*
	?	=	*stocking of non-native species could not be determined*
	*	=	*some or all of the stocking was in a nearby (usually upstream) and presumably connected water body*
	?*	=	*unidentified species were stocked*
[6]*Barr.*	*Presence of permanent, physical barrier to upstream migration*		
	y	=	*yes*
	n	=	*no*
	u	=	*unknown*
	b	=	*a barrier breached by non-native species*
[7]*Activity*	*Land management activities that affect water*		
	d	=	*water removal*
	g	=	*grazing*
	l	=	*logging*
	m	=	*mining*
	r	=	*roads*
	—	=	*no effects reported*
[8]*Figure*	*Figure in Appendix B that contains this stream or lake*		
[9]*Water#*	*Number on figure in Appendix B that denotes this stream or lake*		

Appendix B

Current distribution of Colorado River cutthroat trout in Utah, Utah-Wyoming, Wyoming, and Colorado waters.

Water and figure numbers shown here correspond with those listed on Appendix A.

Legend

Known population

Conservation population

Barrier

Upper Colorado River Basin

Subregion watershed

Hydrologic unit

Wyoming
Utah
Colorado
Arizona
New Mexico
Historical distribution
Locations of conservation populations
Upper Colorado River Basin

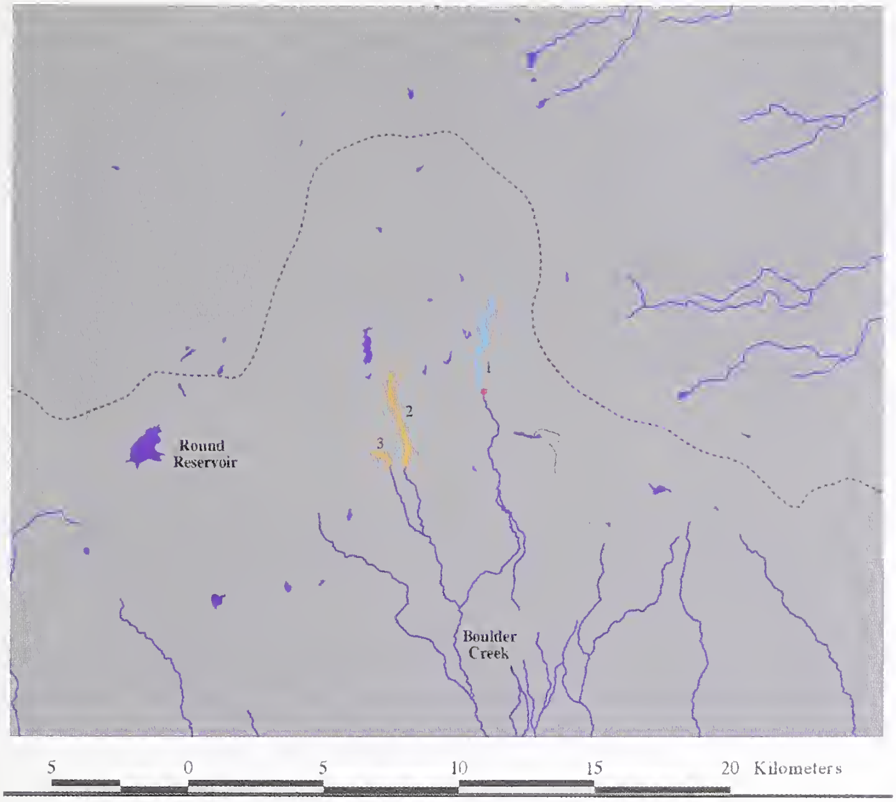


Figure 1. Waters 1-3, Escalante River basin, Utah

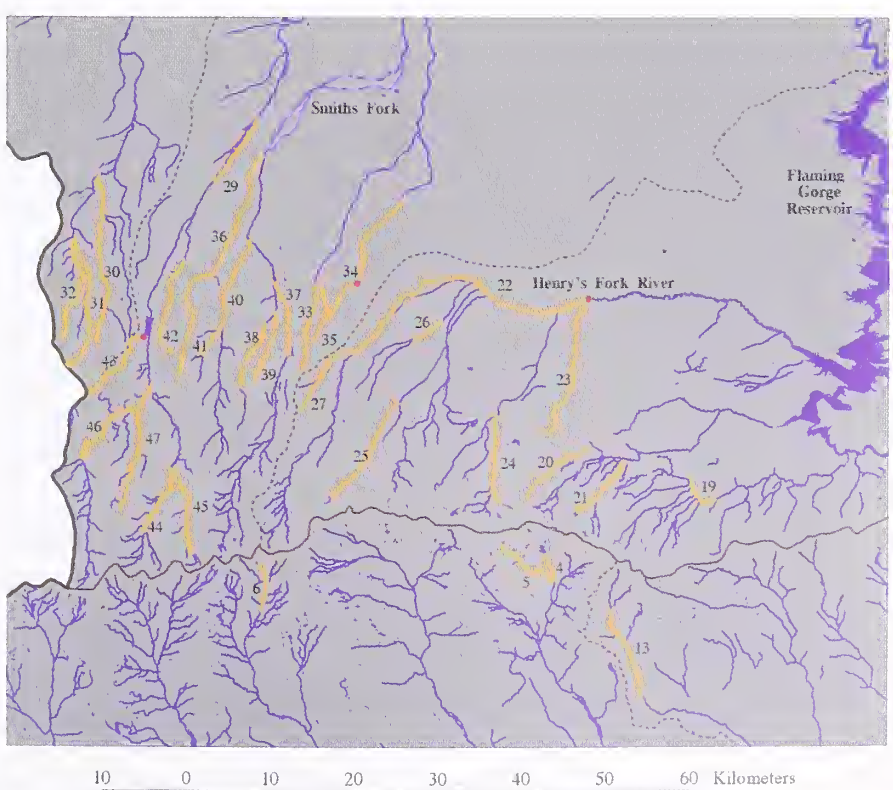


Figure 2. Waters 4-6, 13, 19-27, 29-47, Muddy Creek, Blacks Fork, Ashley Creek, and Flaming Gorge basins, Utah-Wyoming

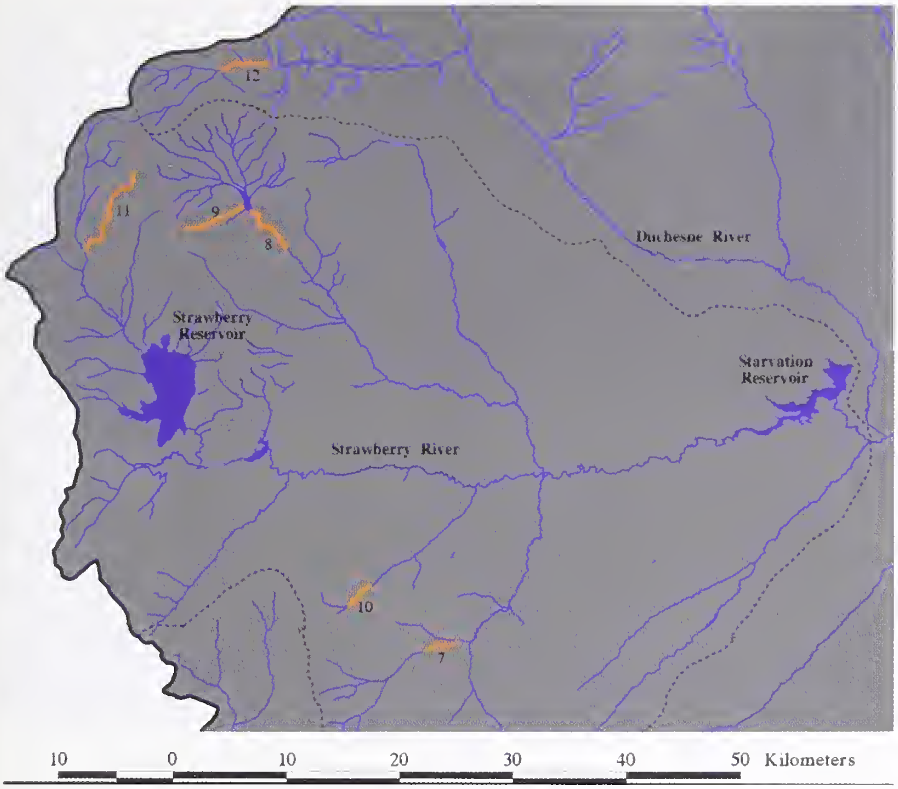


Figure 3. Waters 7-12, Duchesne River and Strawberry River basins, Utah

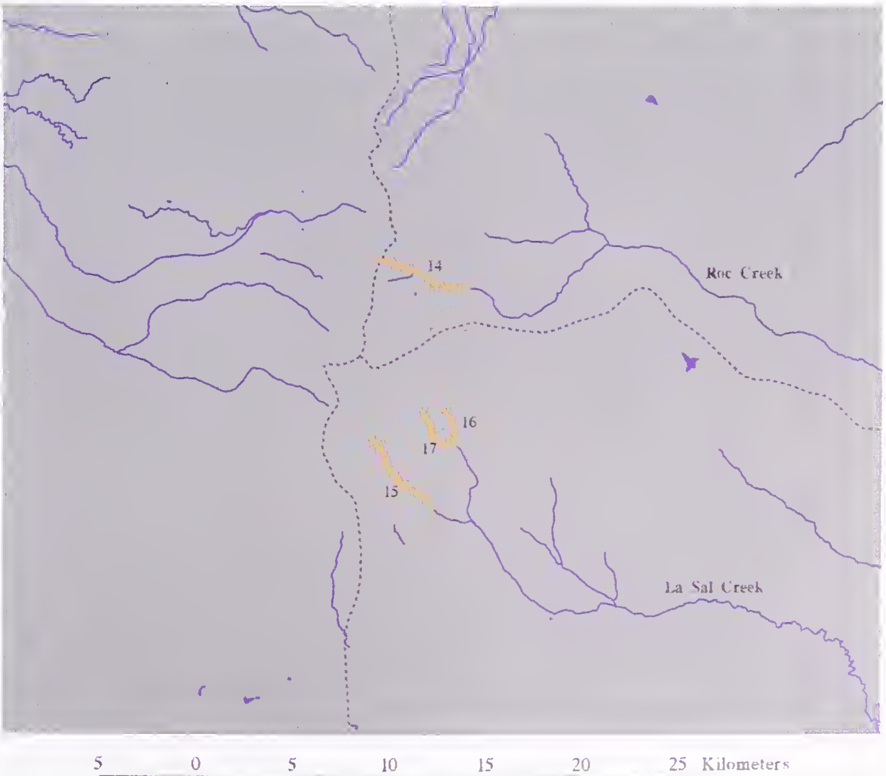


Figure 4. Waters 14-17, Dolores River basin, Utah-Colorado

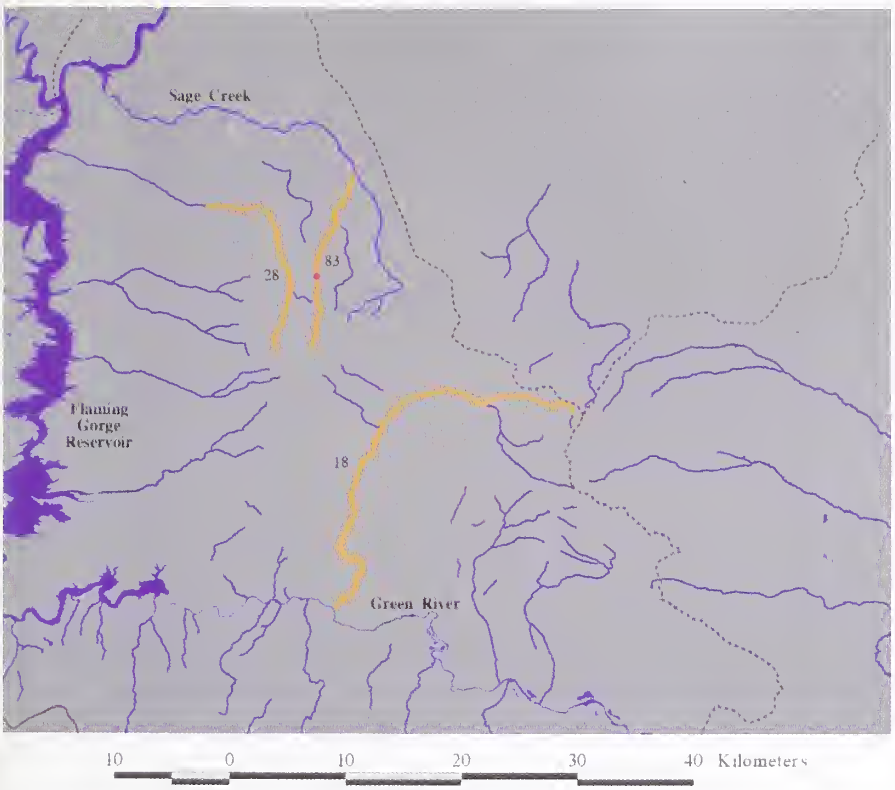


Figure 5. Waters 18, 28, 83, upper Green River and Flaming Gorge basin, Utah-Wyoming

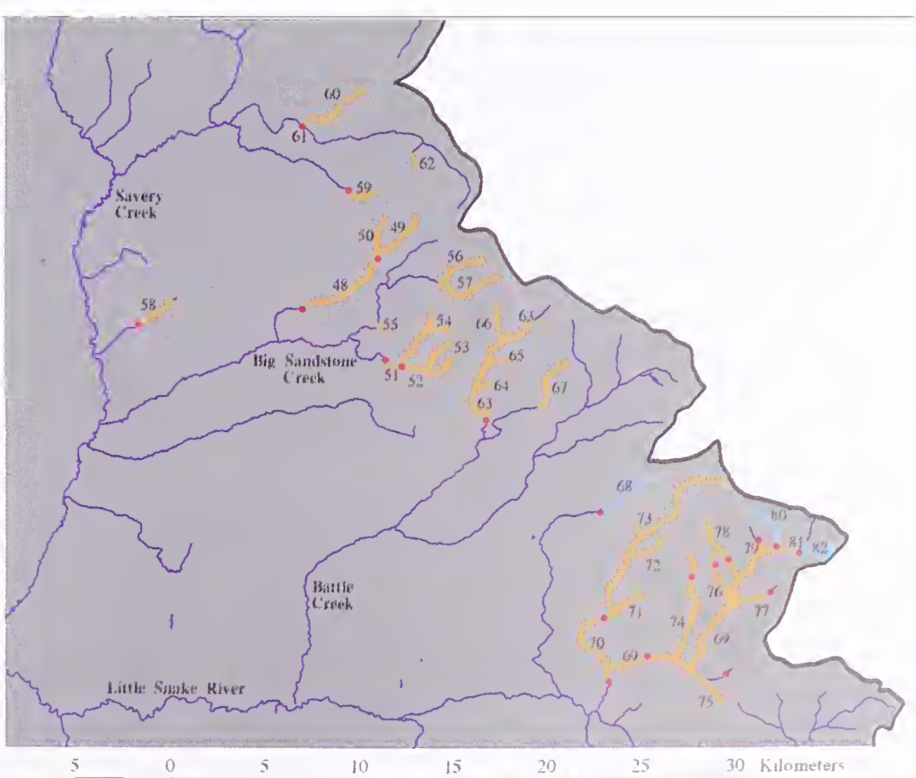


Figure 6. Waters 48-82, Little Snake River basin, Wyoming

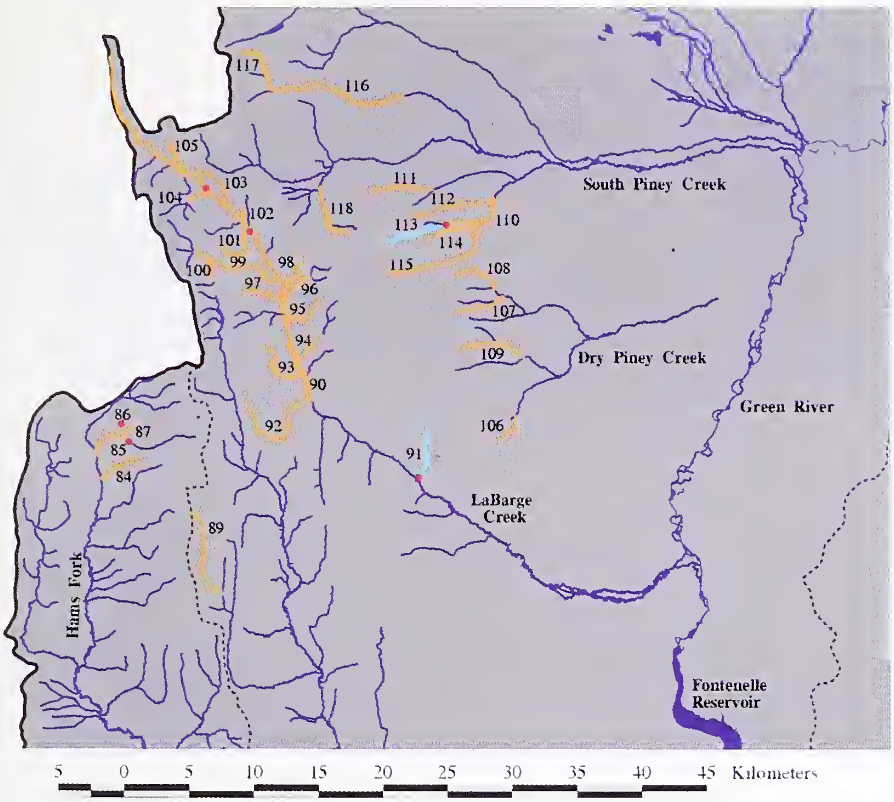


Figure 7. Waters 84-87, 89-118, upper Green River and Blacks Fork basins, Wyoming

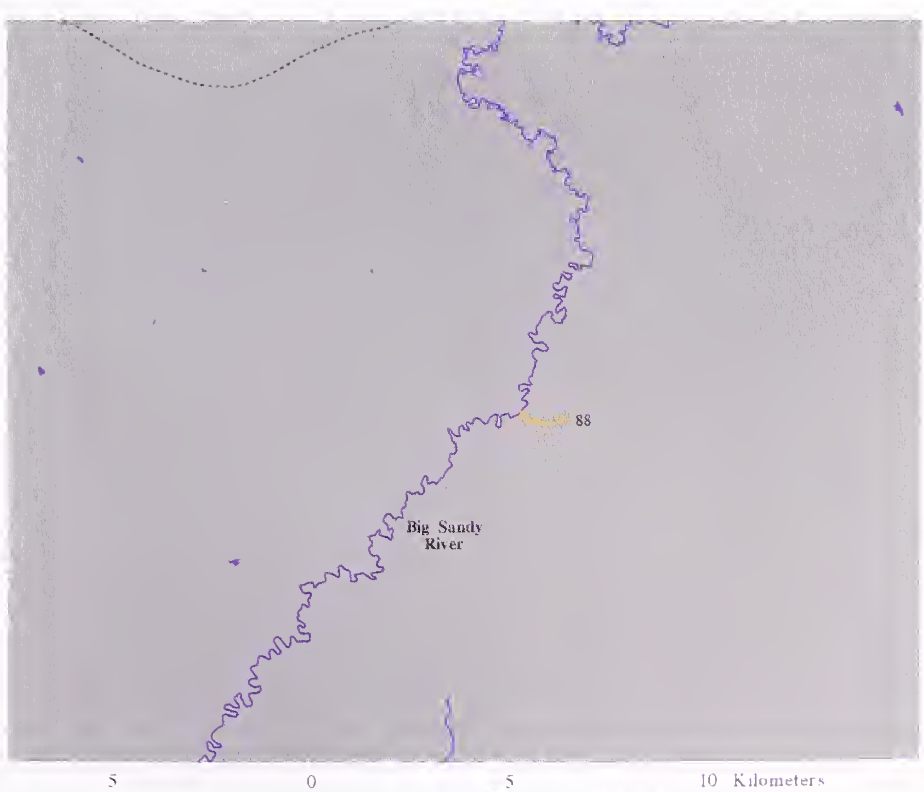


Figure 8. Water 88, upper Green River basin, Wyoming

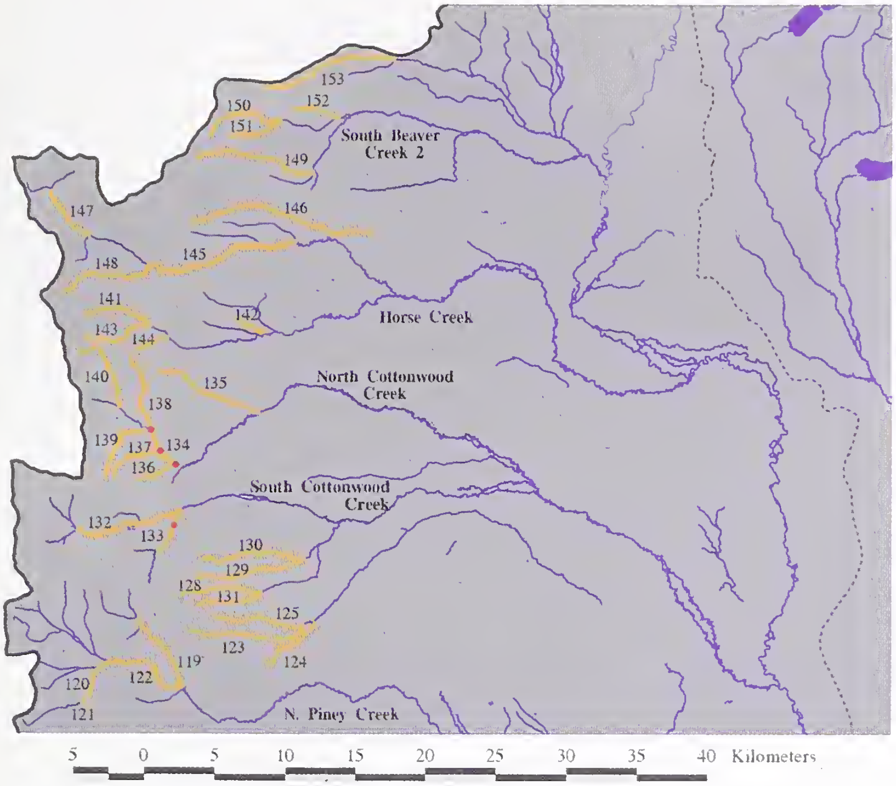


Figure 9. Waters 119-125, 128-153, upper Green River basin, Wyoming

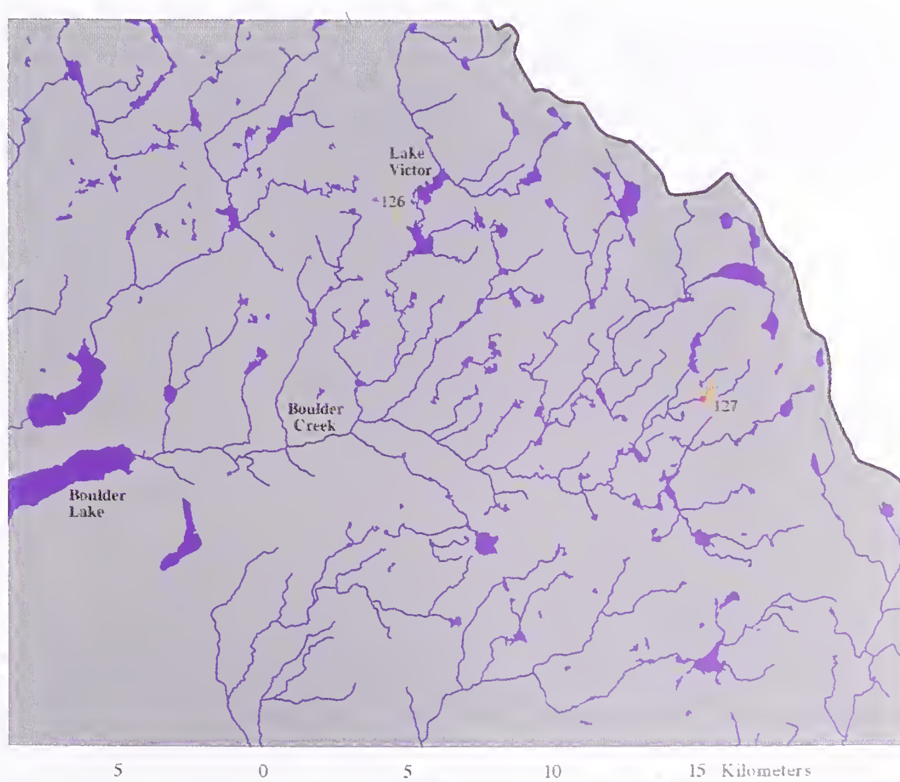


Figure 10. Waters 126-127, upper Green River basin, Wyoming

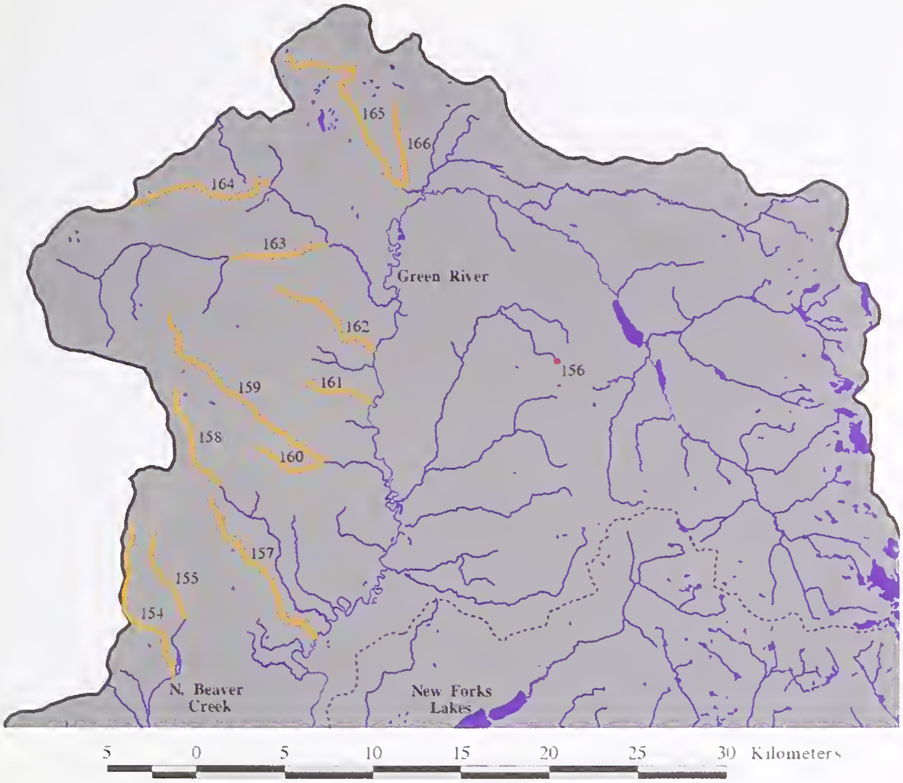


Figure 11. Waters 154-166, upper Green River basin, Wyoming

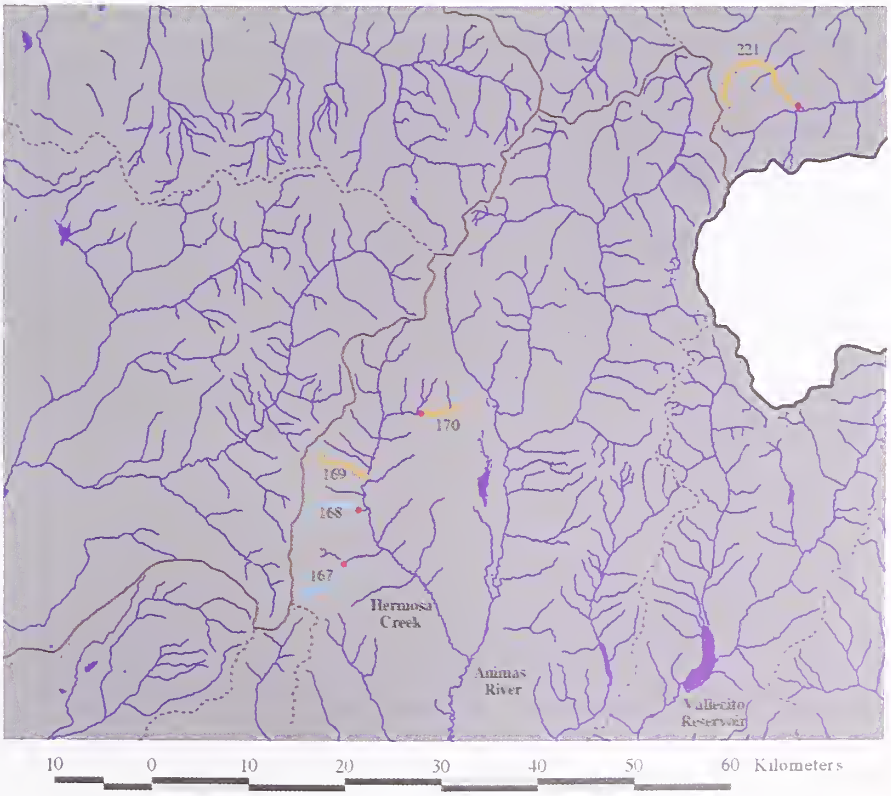


Figure 12. Waters 167-170, 221, Animas River and upper Gunnison River basins, Colorado

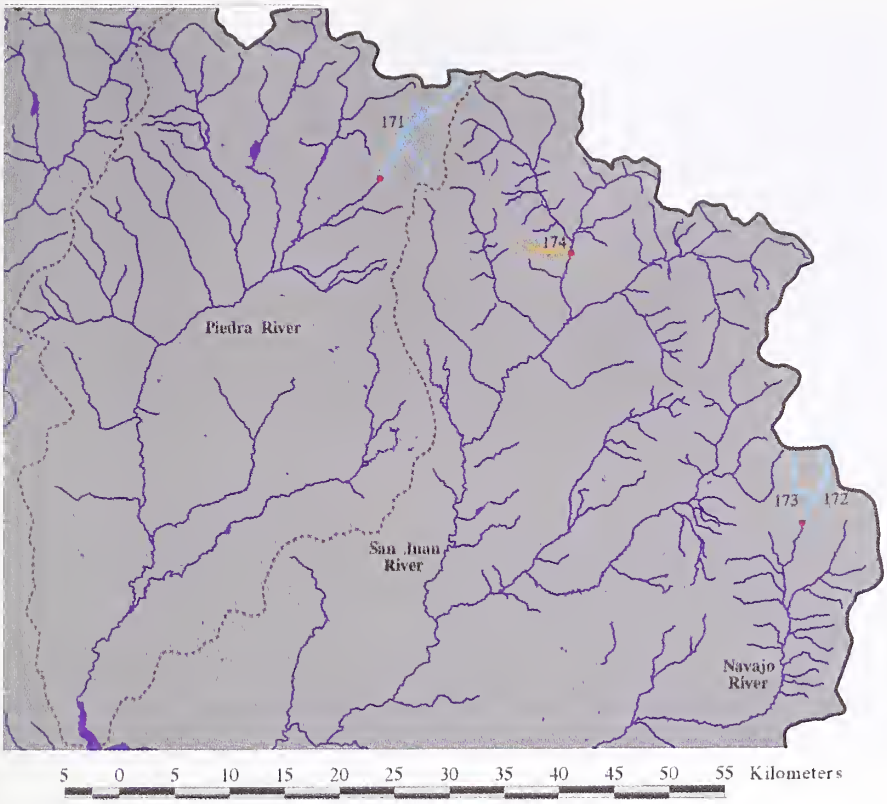


Figure 13. Waters 171-174, upper San Juan River and Piedra River basins, Colorado

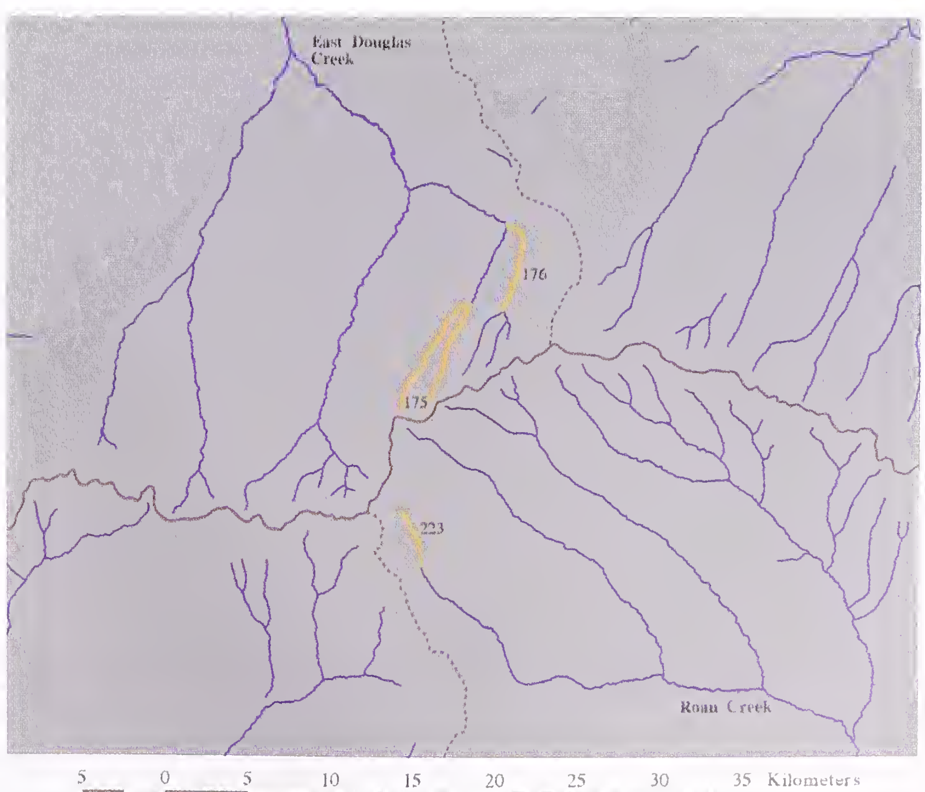


Figure 14. Waters 175, 176, 223, lower White River and Roan Creek basins, Colorado

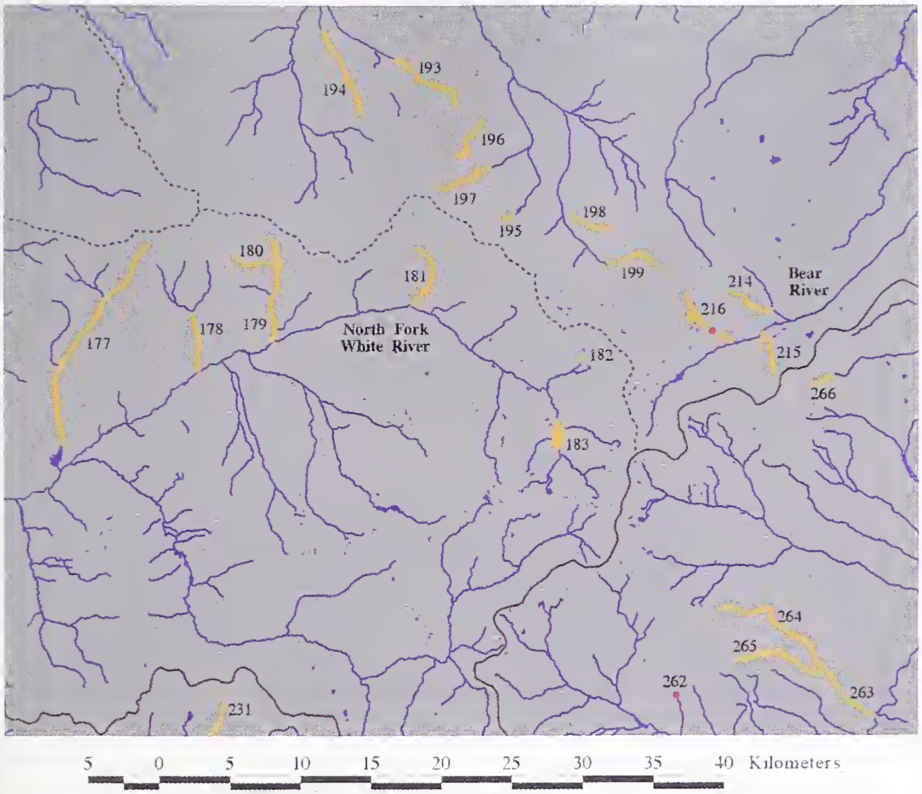


Figure 15. Waters 177-183, 193-199, 214-216, 262-266, upper White River, upper Yampa River, and upper Colorado River basins, Colorado

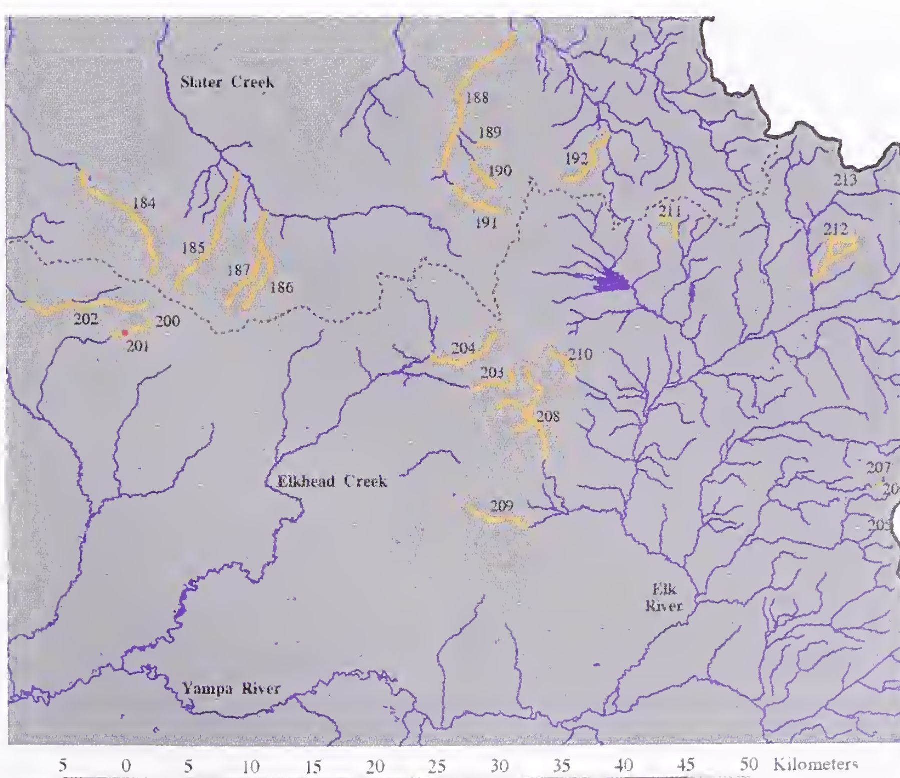


Figure 16. Waters 184-192, 200-213, Little Snake River and upper Yampa River basins, Colorado

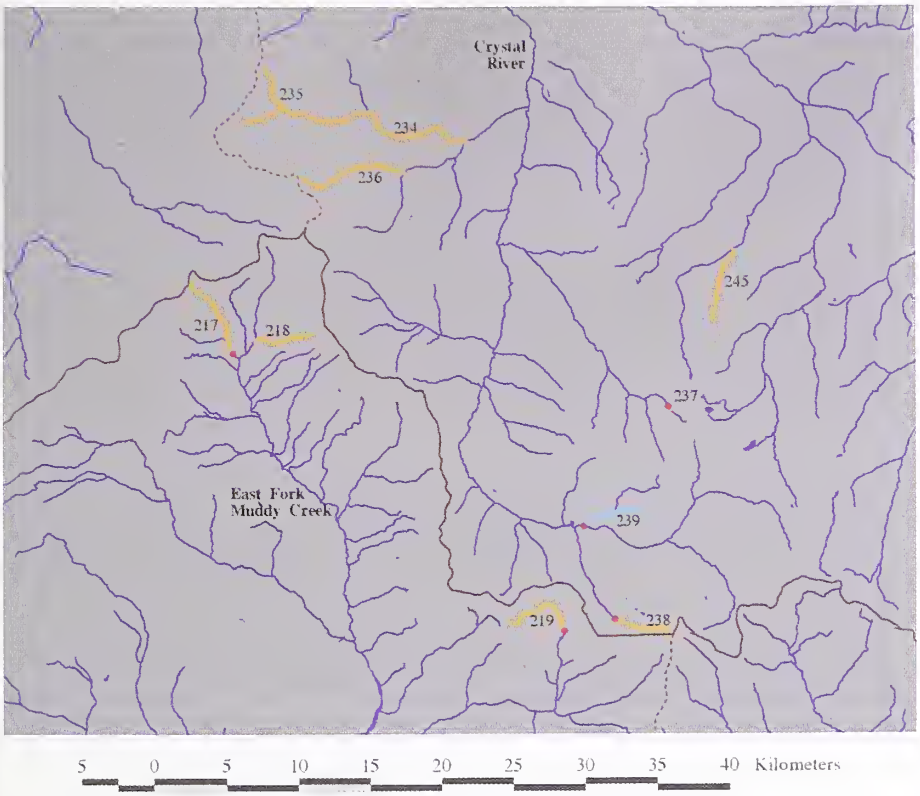
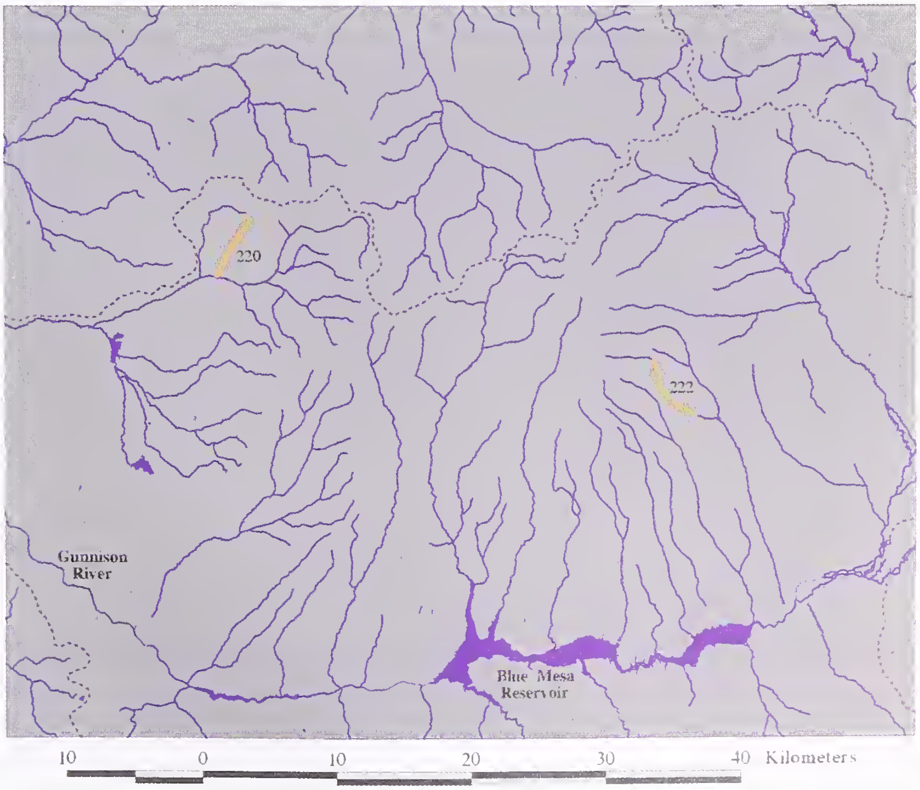


Figure 17. Waters 217-219, 234-239, 245, North Fork Gunnison River and Roaring Fork River basins, Colorado

Figure 18. Waters 220, 222, upper Gunnison River basin, Colorado



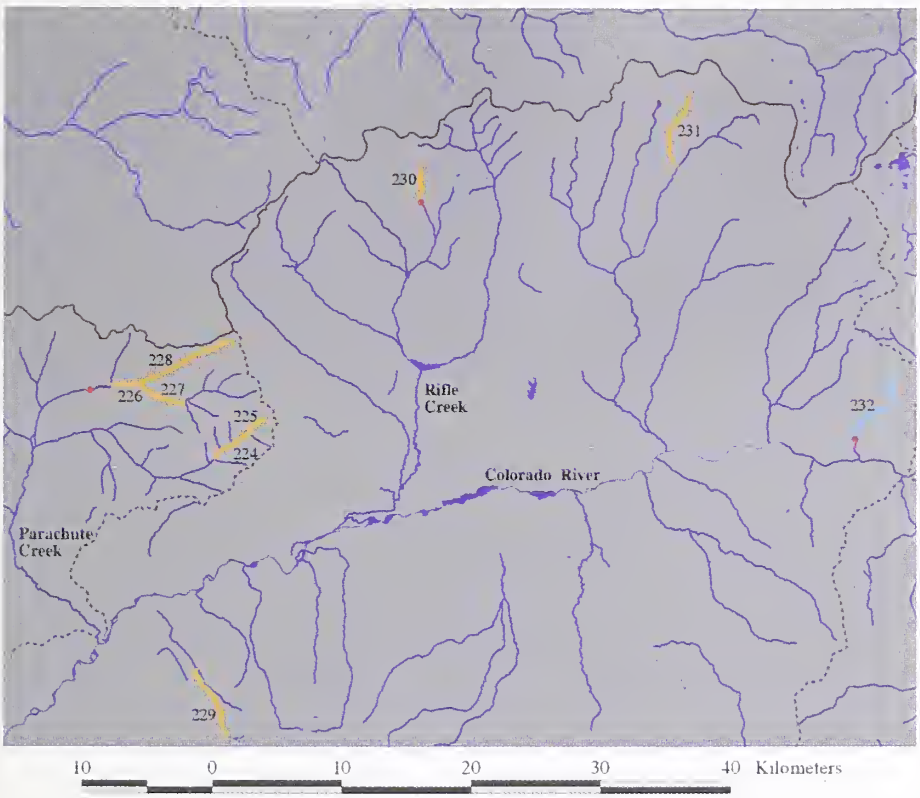


Figure 19. Waters 224-232, Parachute Creek and Colorado River basins, Colorado

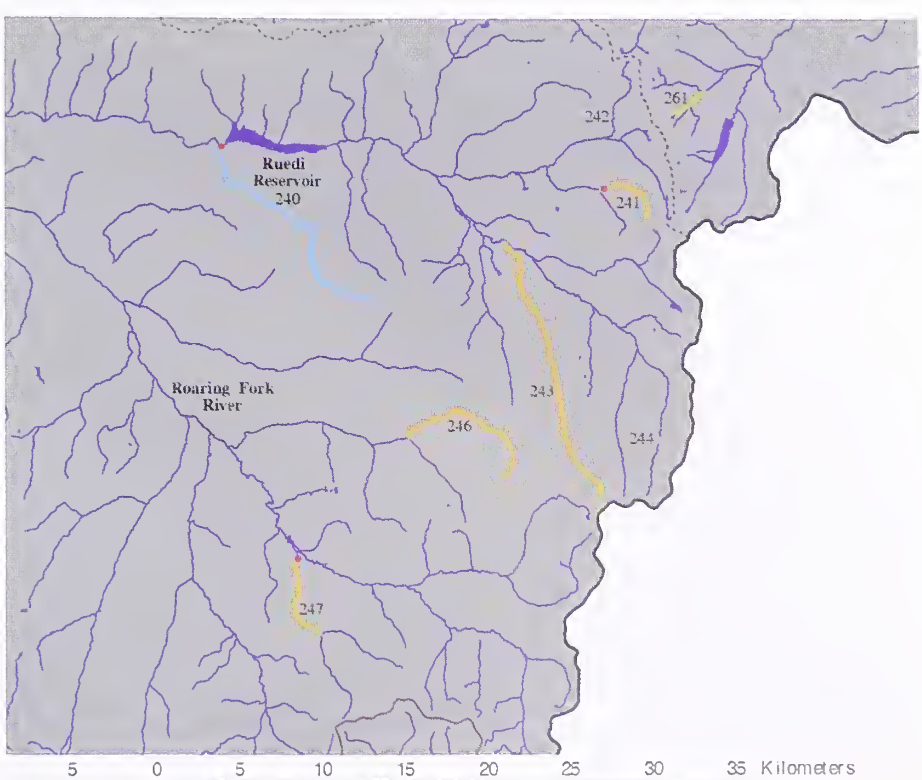


Figure 20. Waters 240-244, 246-247, 261, Roaring Fork River and Eagle River basins, Colorado

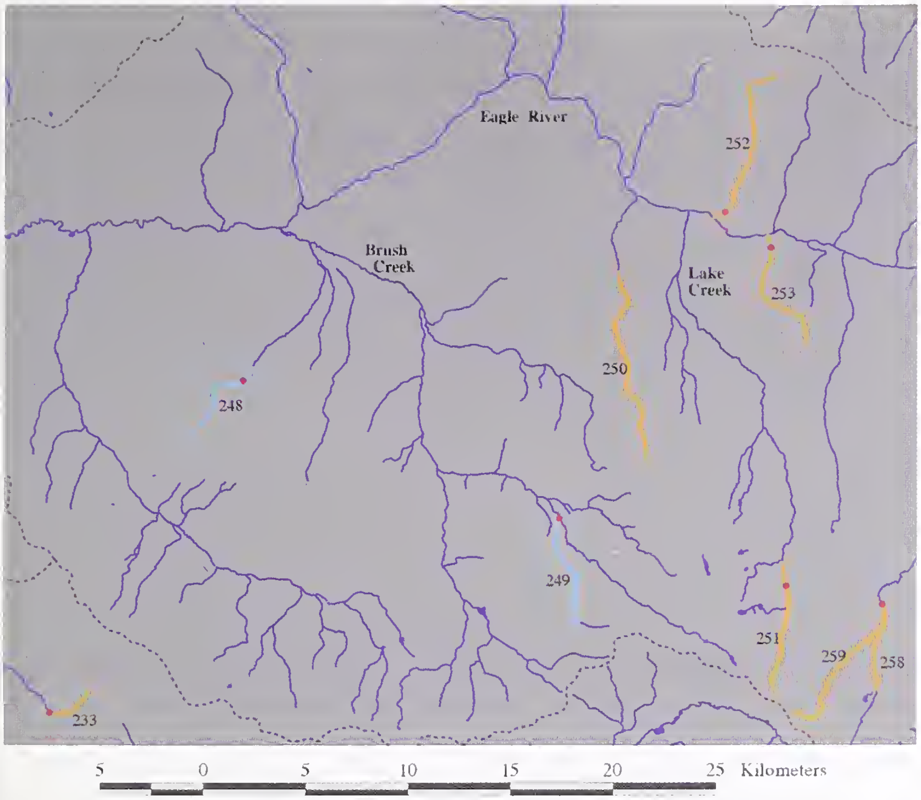


Figure 21. Waters 233, 248-253, 258-259, Eagle River basin, Colorado

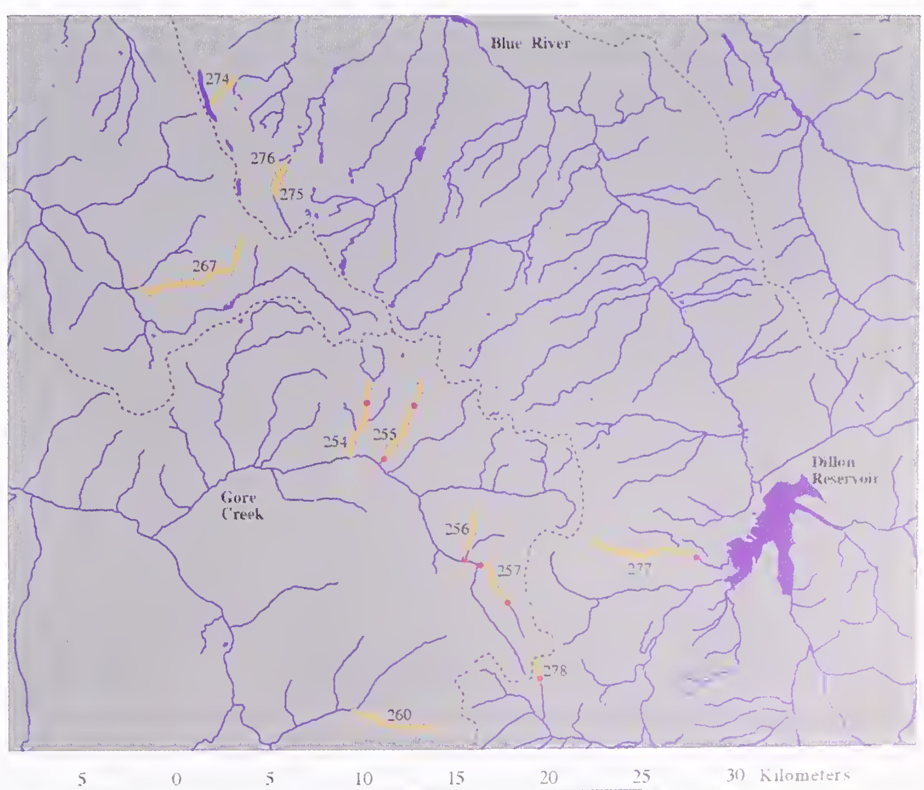


Figure 22. Waters 254-257, 260, 267, 274-278, Eagle River and Blue River basins, Colorado

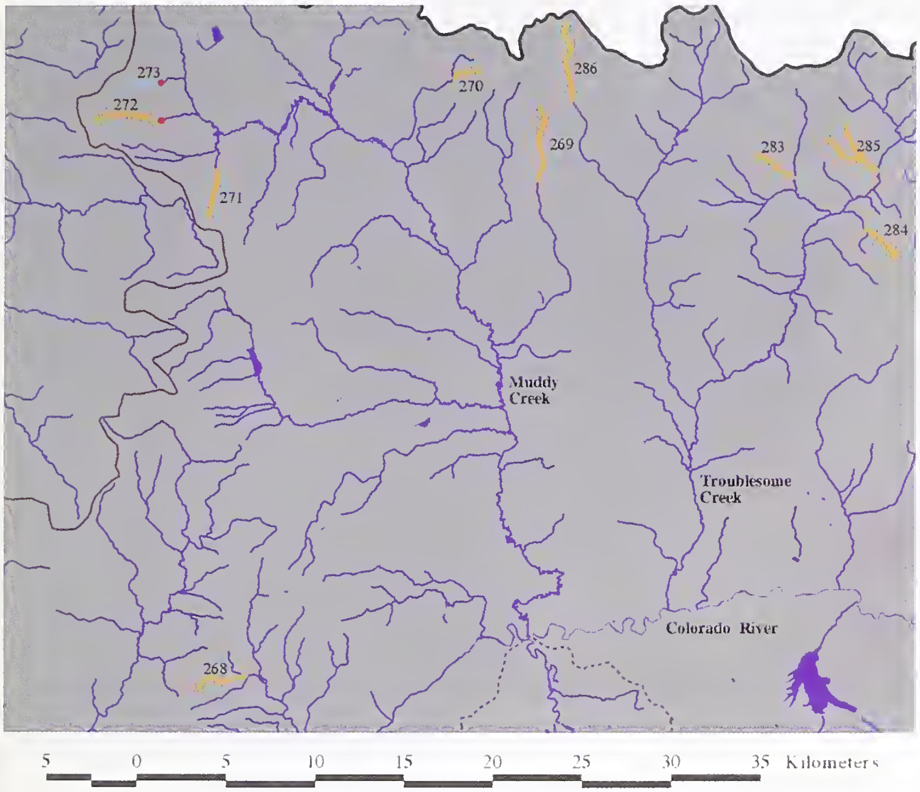


Figure 23. Waters 268-273, 283-286, upper Colorado River basin, Colorado

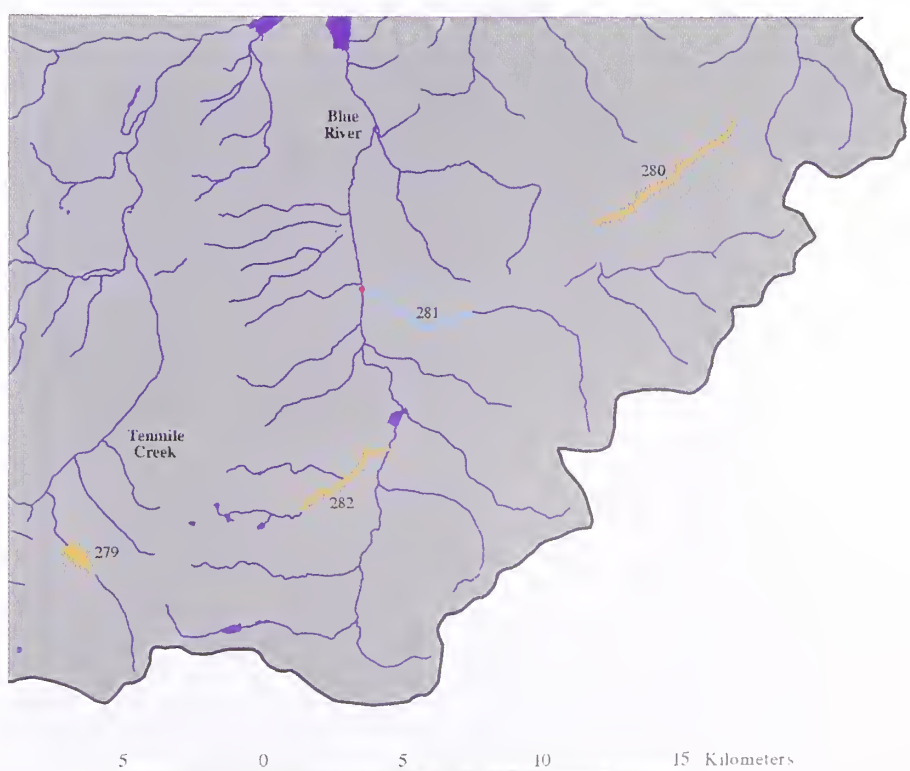


Figure 24. Waters 279-282, Blue River basin, Colorado

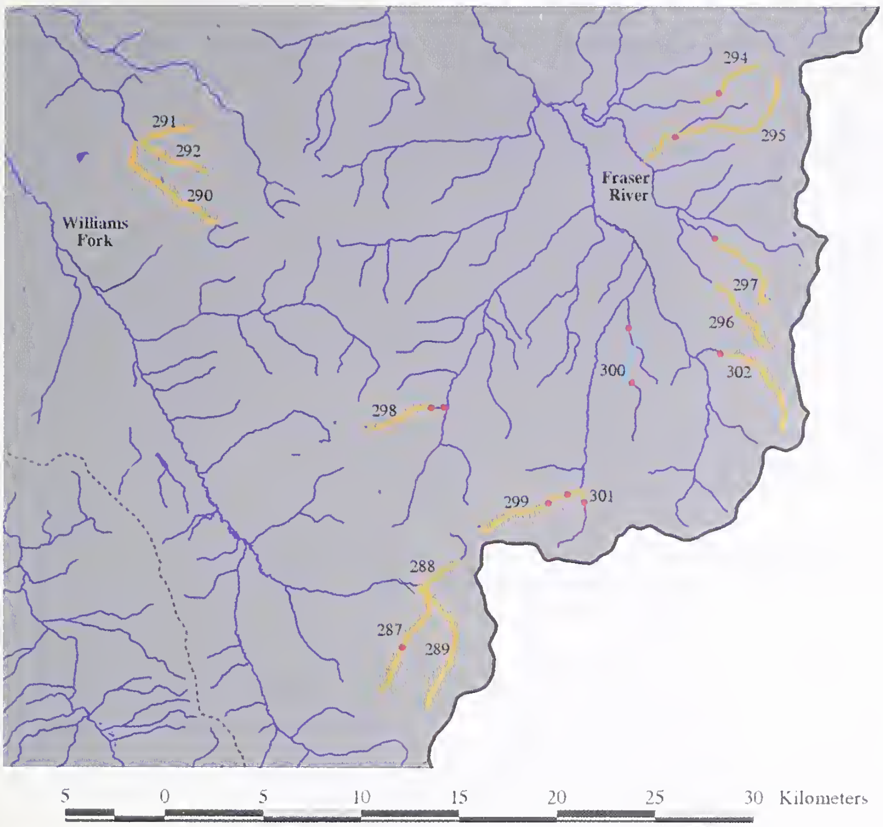
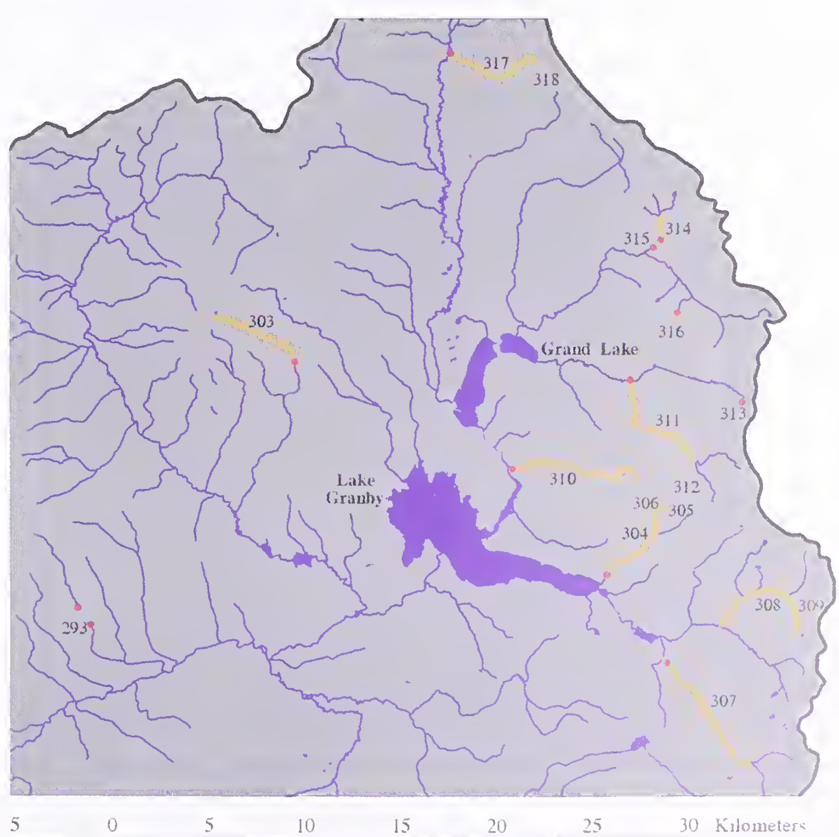


Figure 25. Waters 287-292, 294-302, upper Colorado River basin, Colorado

Figure 26. Waters 293, 303-318, upper Colorado River basin, Colorado



Appendix C

Data sources for specific geographic sites

Utah

Shiozawa et al. 1993; Shiozawa and Evans 1994, 1995a, 1995b

Utah-Wyoming

Binns 1977; Bischoff 1995; Shiozawa and Evans 1995b

Wyoming

Shiozawa and Evans no date; Binns 1977; Remmick 1982; Oberholtzer 1987, 1990; Leary 1990; Leary et al. 1993; Speas et al. 1994; Thompson 1995

Colorado

Wernsman 1973; Behnke and Zarn 1976; Behnke 1979, 1992; Behnke and Benson 1980; Martinez 1988; Langlois et al. 1994

Appendix D

Names of fishes

Salmonidae

Oncorhynchus clarki bouvieri	Yellowstone cutthroat trout
Oncorhynchus clarki pleuriticus	Colorado River cutthroat trout
Oncorhynchus clarki stomias	greenback cutthroat trout
Oncorhynchus clarki subsp.	Snake River fine-spotted cutthroat trout
Oncorhynchus kisutch	coho salmon
Oncorhynchus mykiss	rainbow trout
Oncorhynchus mykiss aguabonita	golden trout
Salmo trutta	brown trout
Salvelinus fontinalis	brook trout
Salvelinus namaycush	lake trout

* APPENDIX A *

INFORMATION SURVEY DATA
FOR
U.S. FOREST SERVICE
HABITAT CONSERVATION ASSESSMENT
INLAND CUTTHROAT TROUT

INVESTIGATOR______________________________ DATE ___/___/____

AGENCY____

MAILING ADDRESS____

____

____

SUBSPECIES__________________ POPULATION NAME/ID______________

DRAINAGE______________________ SUB-DRAINAGE________________

EPA STREAM ID #________________ OTHER ID #___________________

USGS 1:100,000 MAP NAME___________________________________

USGS 7.5 MIN QUADRANGLE MAP NAME___________________________

APPROX. LATITUDE______° ______' APPROX. LONGITUDE______° ______'

PERCENT OF SUB-DRAINAGE ON NAT'L FOREST____________________

NAME OF NAT'L FOREST______________________________________

PERCENT BLM______ PERCENT STATE______ PERCENT PRIVATE______

BAILEY ECOREGION____

****

BASIS FOR THIS INFORMATION ON STATUS AND ABUNDANCE OF POPULATION:
[ ] Actual population estimates;
[ ] Visual observation by trained fisheries professional;
[ ] Estimates based on personal knowledge of local fish resources;
[ ] Based on information gathered from local residents,etc.
[ ] Other____.

YEAR WHEN MOST CURRENT POPULATION DATA WAS COLLECTED____________.

PERCENT OF SUB-DRAINAGE HABITAT OCCUPIED BY SUBSPECIES:
_____% Presently
_____% Historically. When were they last observed?____________.

PERCENT OF HABITAT IN NF PORTION OF SUB-DRAINAGE OCCUPIED:
_____% Presently
_____% Historically. When were they last observed?_______________.

****

THE FOLLOWING SECTION DEALS ONLY WITH
EXISTING POPULATIONS IN THIS SUB-DRAINAGE

WHAT IS THE ORIGIN OF THIS POPULATION?
[ ] Remnant of original native stock
[ ] Reintroduced hatchery reared fish
[ ] Transplanted from other remnant native stock
[ ] Unknown
[ ] Other____

HAS GENETIC PURITY OF POPULATION BEEN DETERMINED BY:
Meristics? [ ] Yes [ ] No What was result?_______________________
Electrophoresis? [ ] Yes [ ] No What was result?_________________
DNA Analysis? [ ] Yes [ ] No What was result?____________________
Other____

COMMENTS ON GENETIC PURITY_______________________________________

____

WHAT IS THE LIFE HISTORY OF POPULATION?
[ ] Resident--No migrations. All life stages in smaller streams.
[ ] Fluvial--Mature fish reside in rivers but migrate to smaller streams to spawn. Rearing habitat is smaller streams.
[ ] Adfluvial--Mature fish reside in lakes but migrage to streams to spawn. Streams provide rearing habitat.
[ ] Unknown

COMMENTS ON LIFE HISTORY____

____

HOW WOULD YOU DESCRIBE THE ABUNDANCE OF THE SUBSPECIES IN THIS SUB-DRAINAGE?
[ ] Abundant
[ ] Common
[ ] Rare
______fish/mi

WHAT IS THE TREND IN ABUNDANCE?
[ ] Increasing
[ ] Stable
[ ] Decreasing
[ ] Unknown

COMMENTS ON ABUNDANCE____

____

WHAT IS THE TREND IN DISTRIBUTION?
[ ] Increasing
[ ] Stable
[ ] Decreasing
[ ] Unknown

COMMENTS ON DISTRIBUTION____

____

WHAT IS THE OVERALL STATUS OF THE POPULATION IN THIS SUB-DRAINAGE?
[ ] Secure-expanding
[ ] Secure-stable
[ ] At Risk-stable
[ ] At Risk-declining
[ ] Unknown

COMMENTS ON STATUS____

____

IS THE POPULATION OF THIS SUBSPECIES REGULARLY MONITORED IN THIS SUB-DRAINAGE?
[ ] Yes
[ ] No
[ ] Unknown

IS SUBSPECIES POPULATION DATA AVAILABLE?
[ ] No
[ ] Yes--Computerized Database. What software format____________
[ ] Yes--Hard Copy

****

THE FOLLOWING SECTION DEALS ONLY WITH
CONDITION OF AQUATIC HABITAT

BASIS FOR YOUR INFORMATION ON CONDITION OF AQUATIC HABITAT;
[ ] Actual habitat surveys;
[ ] Visual observation by trained fisheries professional;
[ ] Estimates based on personal knowledge of local aquatic habitat;
[ ] Based on information from local residents, sportsmen, etc.
[ ] Other____

YEAR WHEN MOST CURRENT HABITAT DATA WAS COLLECTED_________________

STREAM NAME	STREAM ORDER	FISH/MILE OR LB/ACRE	GENETIC PURITY	OTHER

WHAT IS THE CONDITION OF AQUATIC HABITAT IN THIS SUB-DRAINAGE?

National Forest Lands	Other Lands
[ ] Excellent	[ ] Excellent
[ ] Good	[ ] Good
[ ] Fair	[ ] Fair
[ ] Poor	[ ] Poor
[ ] Extremely Degraded	[ ] Extremely Degraded

WHAT IS THE TREND IN HABITAT CONDITION IN THIS SUB-DRAINAGE?

National Forest Lands	Other Lands
[ ] Increasing	[ ] Increasing
[ ] Stable	[ ] Stable
[ ] Decreasing	[ ] Decreasing
[ ] Unknown	[ ] Unknown

COMMENTS ON HABITAT CONDITION________________________________

____

IS THE HABITAT CONDITION FOR THIS SUBSPECIES REGULARLY MONITORED IN THIS SUB-DRAINAGE?

[ ] Yes
[ ] No
[ ] Unknown

IS HABITAT SURVEY DATA AVAILABLE?

[ ] No
[ ] Yes--Computerized Database. What software format____________
[ ] Yes--Hard Copy

****

THIS SECTION DEALS ONLY WITH
FACTORS THAT INFLUENCE POPULATION AND HABITAT CONDITION

WHAT FACTORS MOST INFLUENCE STATUS OF SUBSPECIES POPULATION AND HABITAT CONDITION IN THIS SUB-DRAINAGE?

	NF Lands	Other Lands
Dewatering........................	[ ] yes [ ] no	[ ] yes [ ] no
Altered hydrograph................	[ ] yes [ ] no	[ ] yes [ ] no
Chemical Pollution................	[ ] yes [ ] no	[ ] yes [ ] no
Temperature alterations...........	[ ] yes [ ] no	[ ] yes [ ] no
Impacts to stream morphology......	[ ] yes [ ] no	[ ] yes [ ] no
Lack of wood in streams...........	[ ] yes [ ] no	[ ] yes [ ] no
Sedimentation.....................	[ ] yes [ ] no	[ ] yes [ ] no
Over fishing......................	[ ] yes [ ] no	[ ] yes [ ] no
Competition w/ non-native fish....	[ ] yes [ ] no	[ ] yes [ ] no
Hybridization w/ non-native fish..	[ ] yes [ ] no	[ ] yes [ ] no

Other____

COMMENTS ON INFLUENCING FACTORS____

____

WHAT ACTIVITIES MOST INFLUENCE STATUS OF SUBSPECIES POPULATION AND HABITAT CONDITION IN THIS SUB-DRAINAGE?

	N F Lands	Other Lands
Grazing...........................	[ ] yes [ ] no	[ ] yes [ ] no
Mining............................	[ ] yes [ ] no	[ ] yes [ ] no
Logging...........................	[ ] yes [ ] no	[ ] yes [ ] no
Road Construction/Maintenance....	[ ] yes [ ] no	[ ] yes [ ] no
Wildfire..........................	[ ] yes [ ] no	[ ] yes [ ] no

Other____

COMMENTS ON INFLUENCING ACTIVITIES____

____

****

WHAT ARE RESEARCH NEEDS FOR THIS SUB-DRAINAGE____________________

____

____

WHAT HABITAT SITUATIONS NEED TO BE CORRECTED IN THIS SUB-DRAINAGE?

____

____

WHAT MANAGEMENT ACTIONS DO YOU RECOMMEND TO CORRECT THESE SITUATIONS?____

____

____

DEFINITIONS

SUBSPECIES: Bonneville CTT, Colorado River CTT, Westslope CTT, Rio Grande CTT, Fine Spotted CTT, or Yellowstone CTT.

POPULATION NAME/ID: Optional. Name the subspecies being described. State designated enclave name or other population ID. For purposes of this information survey, a subspecies inhabiting a distinct aquatic ecosystem or interconnected drainage basin with no barriers to genetic exchange may be considered a "population". However, if available information suggests further subdivision into separate populations which would be described differently, use separate data sheets for each "population".

DRAINAGE: Major river drainage e.g. Green River, Snake River.

SUB-DRAINAGE: 3rd to 5th order drainage depending on geographic area. If possible use Hydrologic Unit as described in section 2500 of Forest Service Handbook.

EPA STREAM ID: Optional. EPA STREAM ID number for main stem stream in sub-drainage, or USGS hydrologic unit code (sub-basin).

OTHER ID: Optional. Other state or FS identification that might be helpful.

USGS 7.5 MIN QUADRANGLE MAP NAME: Optional.

APPROX. LATITUDE: Approximate latitude at center of sub-drainage.

APPROX. LONGITUDE: Approximate longitude at center of sub-drainage.

BAILEY ECOREGION: Optional.

HISTORICALLY: Within last 100 years.

STATUS: To classify, reliable information from within the last five years is needed; otherwise, status should be considered "unknown".

ABUNDANT: Individuals are widely distributed and can be readily collected with adequate effort.

COMMON: Individuals are widely distributed and are usually collected with adequate effort.

RARE: Individuals may be widely distributed or restricted in distribution but are infrequently collected with adequate effort.

UPWARD TREND: Abundance or distribution has increased over the last 10 years. Change must be appreciable enough to indicate a trend rather than reflect differences in sampling efficiency or a natural population fluctuation.

STABLE: Abundance or distribution has remained relatively constant over the last 10 years.

DOWNWARD TREND: Abundance or distribution has decreased over the last 10 years. Change must be appreciable enough to indicate a trend rather than reflect differences in sampling efficiency or a natural population fluctuation.

SECURE-EXPANDING: Adults are relatively abundant; recruitment is occurring; abundance trend is upward and/or distribution trend is upward. There are no major threats to aquatic habitat quality; there are no threats from competition or hybridization with exotic fish species.

SECURE-STABLE: Adults are relatively common; recruitment is occurring; most recent abundance and distribution trends are stable. There are no major threats to aquatic habitat quality; there are no threats from competition or hybridization with exotic fish species.

AT RISK-STABLE: Adults are relatively common; recruitment is occurring; most recent abundance and distribution trends are stable. There are major threats to aquatic habitat quality or there are threats from competition or hybridization with exotic fish species.

AT RISK-DECLINING: Adults are relatively rare; recruitment is not occurring; most recent abundance and/or distribution trend is downward. There are major threats to aquatic habitat quality or there are threats from competition or hybridization with exotic fish species.

UNKNOWN: Presence established but insufficient information to classify.

LIFE HISTORY: Specify one or more of the following life history patterns which the population exhibits.

RESIDENT - Entire life cycle is completed in low order stream systems with little or no seasonal migrations.

FLUVIAL - Mature fish reside in large streams but migrate into smaller tributaries to spawn. Juveniles rear for several years in small streams.

ADFLUVIAL - Mature fish reside in lakes but migrate into streams to spawn. Juveniles typically rear for several years in stream environments.

UNKNOWN

REMNANT POPULATION: Specify whether this is a remnant population; non-transplanted fish are known to be present but in very low numbers. Although longterm viability is questionable, the population may constitute a significant portion of the gene pool for that subspecies.

FACTORS INFLUENCING STATUS: If applicable, the following factors should be rated as negative (-) or, in some cases, positive (+) influences on the population status. Leave blank if not applicable or unknown.

ACCESSIBILITY - If the population is vulnerable to overharvest because of ready access, rate negative. If not, rate positive.

HARVEST REGULATIONS - If current regulations appear to provide inadequate protection for the population, rate negative. If regulations are promoting population increases, rate positive. If no effect, leave blank.

POACHING - Rate negative if poaching is a significant threat to the population.

NON-NATIVE SPECIES INTERACTION - Rate negative if non-native fish species are having adverse effects on the population; rate positive if beneficial (e.g., increased forage base).

HABITAT CHANGE - If habitat change is occurring, rate it as negative or positive influences on the population for the following components:

Physical Condition - includes diversity, substrate, cover, LOD, etc.
Water Flow - includes quantity and fluctuation.
Water Quality - includes chemical parameters and temperature.

MAJOR CAUSES OF HABITAT CHANGE: Check all of the following that apply.

FOREST MANAGEMENT - Road construction and timber harvest, riparian management, watershed management.

AGRICULTURE - Irrigation, agricultural runoff, etc.

MINING GRAZING HYDROPOWER OTHER

COMMENTS: Include any relevant or explanatory material.

INVESTIGATOR: List person(s) and date of those who prepared or who could best answer questions about this population.

NAME, AGENCY, ADDRESS and PHONE NO.

MAPS: To provide a complete picture of cutthroat trout subspecies distribution, please provide maps that delineate (with your best available knowledge) historic and current populations. Include these maps with your survey data sheets. Provide maps for all data sheets you complete. Use a map scale of 1: 100,000 only. Color code as follows: Red = Historic populations; Green = Current populations.

DEFINITIONS OF CONSERVATION ASSESSMENTS, STRATEGIES, AGREEMENTS

(Habitat) Conservation Assessment: A comprehensive, state-of-knowledge technical document that describes life history, habitat requirements and management considerations for a species or group of species throughout its/their occupied range on the lands managed by cooperating agencies. These assessments do not dictate changes to forest plans nor should they contain management direction triggerering NEPA and NFMA requirements.

Conservation Strategy: A document that contains biological information and management recommendations necessary for the conservation of a sensitive species. Implementing a conservation strategy on NFS lands will require NEPA and NFMA requirements be satisfied.

Conservation Agreement: A formal written document agreed to by FWS and another Federal agency, Tribe, State agency, local government, or the private sector to achieve the conservation of candidate species through voluntary cooperation. It documents the specific actions and responsibilities for which each party agrees to be accountable. The objective of a Conservation Agreement is to reduce threats to a candidate species and/or its habitat. An effective Conservation Agreement may lower listing priority or eliminate the need to list a species. Agreements must be consistent with NEPA and NFMA requirements.